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INFLUENCE OF GRAZING SYSTEMS ON WILD TURKEYS (*Meleagris gallopavo merriami*) IN MIXED CONIFER VEGETATION, LINCOLN NATIONAL FOREST, NEW MEXICO

Sanford D. Schemnitz

FINAL REPORT

INFLUENCE OF GRAZING SYSTEMS ON WILD TURKEYS (*Meleagris gallopavo merriami*) IN MIXED CONIFER VEGETATION, LINCOLN NATIONAL FOREST, NEW MEXICO

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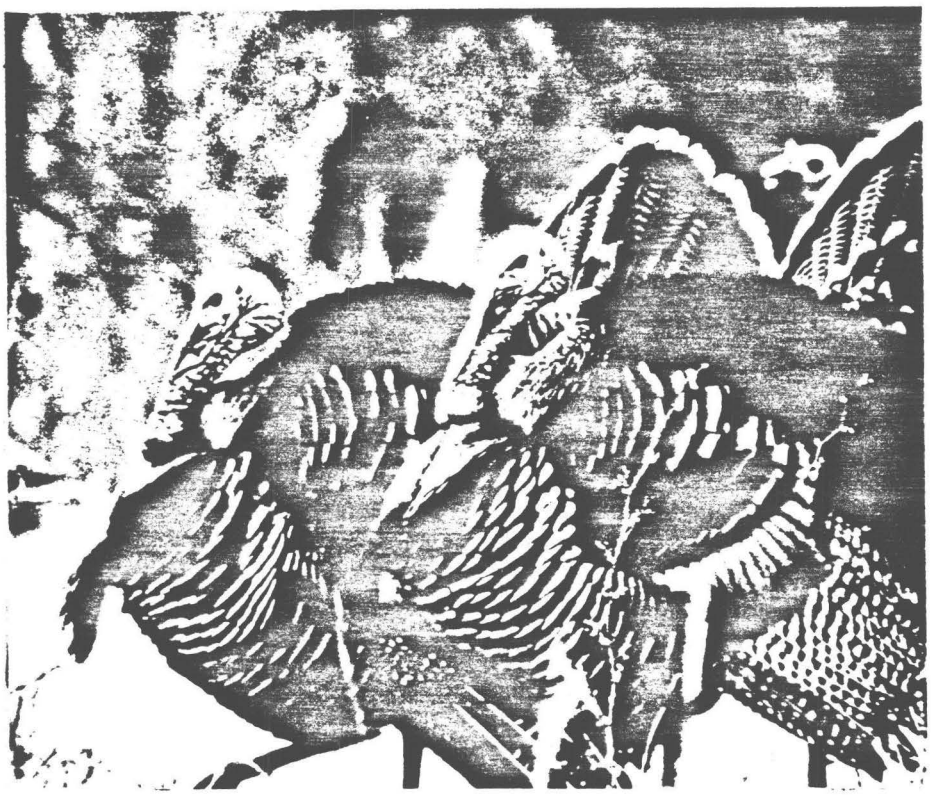

Frontispiece. Majestic turkey gobblers, the trophy birds of the Sacramento Mountains.

ABSTRACT

Merriam's wild turkey (Meleagris gallopavo merriami) nesting, brood-rearing and roosting habitats were studied during 1979-1982 on the Lincoln National Forest, Otero County, New Mexico. A rest-rotation and a continuous summer seasonal grazing system were compared to ascertain differences in their effect on turkey habitat needs. The influence of past silvicultural practices was also assessed.

Nesting habitat varied considerably with many habitat types and seres utilized. Overhead canopy density at nests was higher than the surrounding stand. Grazing and selective cutting did not appear to adversely affect the quality of nesting habitat or nest success. No nests were found in clearcuts. One of the most important factors limiting nest success was low egg fertility. Nest predation was 31%.

Brood-rearing habitat was less variable and consisted of small openings in mixed conifer stands, meadow borders and aspen glens. Hens with poults did not favor either grazing system nor did brood site vegetation (composition, cover and height) vary between systems. Selective timber cutting appeared to enhance brood-rearing habitat by creating the small openings utilized by feeding poults, but clearcuts larger than 2 ha were not used.

Summer roosts were found on varying slope aspects and rarely used more than once. Winter roosts, however, were oriented on northeasterly aspects, were closer to water and were utilized repeatedly by large winter flocks. Summer and winter roost trees were mostly dominant or codominant white firs (Abies concolor) and Douglas firs (Pseudotsuga menziesii), but varied considerably in diameter, height

and vigor. The minimum stand density utilized was 80 ft^2/acre (18 m^2/ha). Winter roosts generally indicated important wintering areas for turkey flocks that showed no seasonal migration.

Turkeys fed mostly on grasses and forbs during the summer, winter, and spring seasons. During fall, seeds and berries of shrubs and grasses were the food items most utilized.

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INTRODUCTION

Wild turkey (Meleagris gallopavo merriami) research in New Mexico has been meager, particularly in recent years, despite the importance of the species as a game bird. Ligon (1946) outlined the life history, food habits and management practices such as trapping and transplanting. Spicer (1959) evaluated predator control, supplemental feeding and water development in northern New Mexico. MacDonald (1960-64) described habitat preferences of Merriam's turkey in New Mexico and found cutover mixed conifer stands were preferred over virgin stands.

This study focused on the nesting, brood rearing and roosting requirements of Merriam's turkey in mixed conifer habitats. These habitat requirements were in turn related to livestock grazing and silvicultural practices to determine the effects of these land uses on turkey habitat needs.

Specific objectives were:

1. Locate and describe wild turkey nest sites, brood rearing sites and roost sites.
2. Identify the important habitat parameters for which the above are selected.
3. Compare the effects of rest-rotation versus continuous grazing systems on turkey habitat needs.
4. Determine effects of silvicultural practices on wild turkey habitat needs.
5. Develop management recommendations to enhance wild turkey habitat that are compatible with other land uses including grazing and timber management.

The fact that livestock grazing influences vegetative cover, composition and height has been well-documented (Craddock and Forsling 1938, Hurtt 1946, Johnson 1953, Launchbaugh 1957, Klipple and Costello 1960, Skovlin et al. 1976), but studies pertaining to the impact of grazing on wild turkey welfare, production and survival are few in number. Merrill (1975) found that overgrazing in Texas limited nesting habitat of Rio Grande Turkeys (M. g. intermedia), but for Merriam's turkey no such relationship has been documented.

In Colorado, Burget (1957) concluded from 7 observations of nesting hens that they preferred steep slopes covered by dense thickets of scrub oak (see Appendix B for scientific names) or areas of cutover ponderosa pine where slash remained. Schorger (1966) stated that Merriam's turkey generally nest on northern slopes from 2100 m to 2850 m, and Ligon (1946) found cover around turkey nests to be either lacking or consisting of fallen pine branches. Only one study by Petersen and Richardson (1975), in South Dakota, described nest sites for Merriam's turkey in detail. Easterly slopes were preferred, with grassy meadows, pine slash and tree bases selected for nesting.

Concerning brood rearing habitat in Arizona, Phillips (1982) found heavy grazing to have a negative impact on poult production, and Reeves (1953) found that hens with poults favored ungrazed, fenced exclosures for feeding activity. Other studies involving the eastern wild turkey (M g. silvestris), in Alabama, suggest that brood habitat is enhanced by moderate levels of grazing (Hillestad and Speake 1970, Speake et al. 1975).

Literature is lacking on the roost site characteristics of turkeys occupying mixed conifer forests. Studies by Burget (1957), Hoffman (1962,

1968, 1973), Jonas (1966) and Boeker and Scott (1969) on Merriam's turkey roosts in ponderosa pine forests indicated a preference for overmature, open-crowned ponderosa pine roost trees, easterly slopes and some tolerance to selective cutting.

Because of the lack of information concerning the wild turkey in New Mexico, this study was undertaken to elucidate quality nesting, brood rearing and roosting habitat for Merriam's turkey in mixed conifer vegetation. Field work was conducted from January 1979, through August 1982, in the Cloudcroft District of the Lincoln National Forest. Major funding was provided by the Lincoln National Forest, New Mexico Department of Game and Fish and the New Mexico State University Agricultural Experiment Station. Additional funding was provided by the New Mexico Wild Turkey Federation.

STUDY AREA

An area of approximately 36400 ha was selected in the Cloudcroft District of the Lincoln National Forest, Otero County, New Mexico (Figure 1). The criteria used in determining the size, shape, and location of the study area were:

1. the range and dispersal typically associated with Merriam's turkey
2. the desire for a study in predominantly mixed conifer habitat
3. the equal representation of the two grazing systems being compared.

Elevations range from 2300 m to 2960 m with mountainous topography, gently sloping to moderately steep on ridge tops and valley areas to very steep on side slopes (Figure 2). Soils are predominantly of the Caballo-Peso-Rockland association and Peso-Mescalero association (Maker et al. 1972). They are typically dark colored, with a moderate to high content of organic matter. The soils originate from materials weathered residually from underlying limestone bedrock or in colluvial and alluvial sediments from such rocks.

The area is completely within the mixed conifer associations described by Moir and Ludwig (1979), and includes six forested climax types, a nonforested dry meadow type and many seral associations (Appendix A). Major overstory trees are white fir (see Appendix B for scientific names), Douglas fir, Engelmann spruce and blue spruce. Major seral trees include southwestern white pine, ponderosa pine, aspen and Gambel oak.

Figure 1. Grazing systems and brood ranges in study area, Cloudcroft District.

Figure 2. Aerial view showing mixed conifer vegetation and dissected terrain typical of the study area. Burned areas appear in foreground and the dry meadow habitat is visible along main draw of Sacramento Canyon, June, 1980.

Logging and livestock grazing have been in effect since the 1880's and fire has been a predominant factor in maintaining large areas of seral vegetation (U.S. For. Serv. 1978).

Two grazing systems were in effect in the study area (Figure 1). A rest-rotation system was implemented in 1979 in half the study area (18200 ha) wherein 3 of 9 pastures are rested each year. The remainder of the area was in a continuous summer seasonal grazing system. Both areas received only seasonal use (May through October) so that no livestock were present during the winter months.

The climate is montane continental, characterized by cold winters and mild summers. At Sunspot Observatory, located in the study area, the mean annual precipitation is 59.6 cm (Demastus 1976). Two-thirds of the annual precipitation is contributed by summer thunderstorms. The balance occurs in the form of snow, with an annual mean accumulation of 182.4 cm. The freeze-free period averages 143 days, with temperature minima and maxima means of 10°C and 23°C in the summer and -6°C and 3°C in the winter. Record extremes are 34°C and -31°C. Seasonal temperature variations and total precipitation during the study were normal, with the exception of snowfall patterns. Snowfall accumulation (292 cm) was much greater than normal the first winter (1978-79), but normal the following winter (1979-80). However, unusually late spring snowstorms occurred the second season of the study, with 25.4 cm of snow falling on May 3, 1980.

METHODS

In March of 1979, 13 turkey hens were cannon-netted (Dill and Thornsberry 1950), sexed, aged (Keiser and Kozicky 1943) and weighed, equipped with radio transmitters, patagial wing tags, leg bands, and immediately released (Figure 3). A 170-gm pulsed signal transmitter (Telonics model MKVM-4a) was mounted on the birds' backs using leather straps tied around the base of the wings. The Telonics model TR-2 biomedical telemetry receiver with multielement antenna was used for tracking.[1]

During the next three winter seasons (1980, 1981, 1982), 57 additional hens were captured using either a cannon net or a modified pole trap (Phillips 1982). These additional hens were treated similarly to those that were captured in 1979. During all four years, these hens were tracked to locate nests, brood-rearing sites, and roost sites to determine which habitat parameters were important factors of selection.

Nest Sites

When a nest was located, no attempt to measure the site was made until incubation was terminated to minimize disturbance of the nesting hen. Many hens flushed due to initial location efforts, but most hens returned to the nest within 24 hours.

Vegetation was classified according to Moir and Ludwig (1979), based on the concept of habitat types (Daubenmire 1968), except when

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[1]Additional telemetry information is available from the manufacturer: Telonics, Telemetry Electronics Consultants, 932 E. Impala Ave., Mesa, Arizona, 85204.

Figure 3. Subadult hen turkey equipped with radio transmitter and patagial wing tags ready for release, March, 1980.

seral species dominated the site. Then, vegetation was typed according to dominant species (i.e., a mixed conifer disturbed site of more than 50% aspen would be typed as "aspen" and not the potential climax).

Slope was measured using a "Suunto" clinometer and exposure was determined from compass bearings. Canopy cover was measured using a spherical densiometer (Lemmon 1956) as modified by Strickler (1959) and basal area (BA) of trees and stumps was measured using a variable plot 10 ft^2/acre (2.3 m^2/ha) prism. Heights, diameters at breast height (dbh) and ages of surrounding trees were measured using standard forestry procedures (Husch et al. 1972).

During the first two years of the study, understory cover, composition and height of vegetation around the nest were determined using a step-point sampling procedure (Evans and Love 1957). Eight transects were paced radially from the nest and eight points sampled along each transect at 2 m intervals out to 16 m from the nest (Figure 4). Transect lines were randomly oriented within each 90° arc so that two lines occurred within each quadrat. One transect in each quadrat was then extended for 32 m (16 more sample points) to sample the area outside the immediate nest site and meaure any differences for which the site may have been selected. Canopy cover and BA were measured again at the end of each long transect. This procedure was abandoned during the second two years of the study as the results of the first two years showed that height and composition of understory cover did not have a great affect on nest site selection.

A horizontal density board as described by Wight (1938) and modified by Nudds (1977) was used to determine vegetative cover around the nest at 0.3 m vertical intervals. The board was positioned vertically

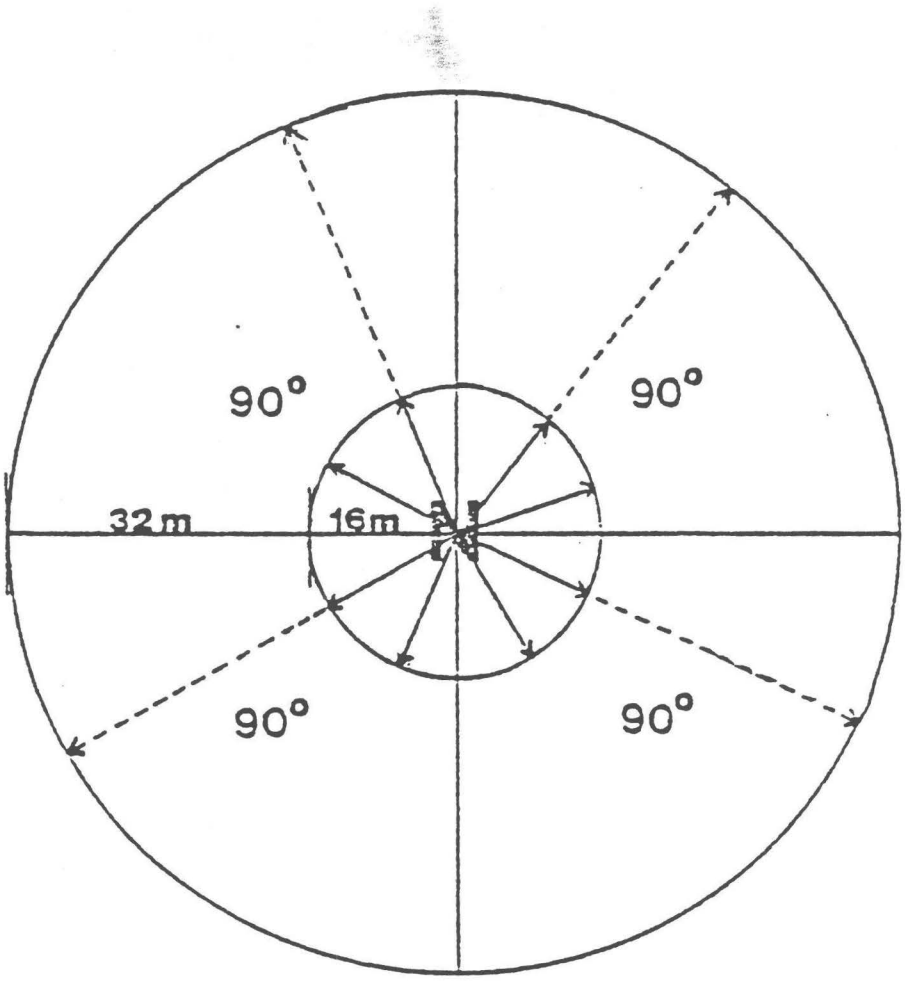

Figure 4. Arrangement of step-point transects around the nest, 1979 and 1980.

at the nest and percent cover estimated from four positions along one transect line in each quadrat at 4 m intervals. This procedure was modified slightly during the second two years of the study by estimating the cover at 10 m intervals instead of 4 m intervals. Also, at the end of each transect an additional 40 m was paced out from the nest where canopy cover and BA measurements were then made (Figure 5). Elevation and distances to nearest water source, road, and opening were determined by pacing or from Forest Service maps.

Egg fertility was determined by examining all eggs that failed to hatch, but were known to have been incubated at least 48 hours. Eggs that showed no sign of development were assumed to be infertile (Stoll and Clay 1975). Nest predators were identified according to evidence provided by tracks, hair, and egg fragments (Rearden 1951).

Brood-Rearing Sites

Brood use areas were determined from tracking radio-tagged hens with poults and from sightings reported by reliable observers frequenting the area. All sightings of hens with poults were not considered "brood-rearing sites," but only those where the hen and brood were actually observed feeding or seen repeatedly in the same area. Habitat parameters at brood sites were measured in the same manner as for nests with two exceptions. The first exception was, that during the first two years all "step-point" transects were 16 meters in length and were subsequently lengthened to 20 m during the second two years. Also, horizontal vegetative cover was not determined.

Grazing utilization by livestock was estimated from height/weight ratios of key grasses (Kentucky bluegrass and nodding brome) which

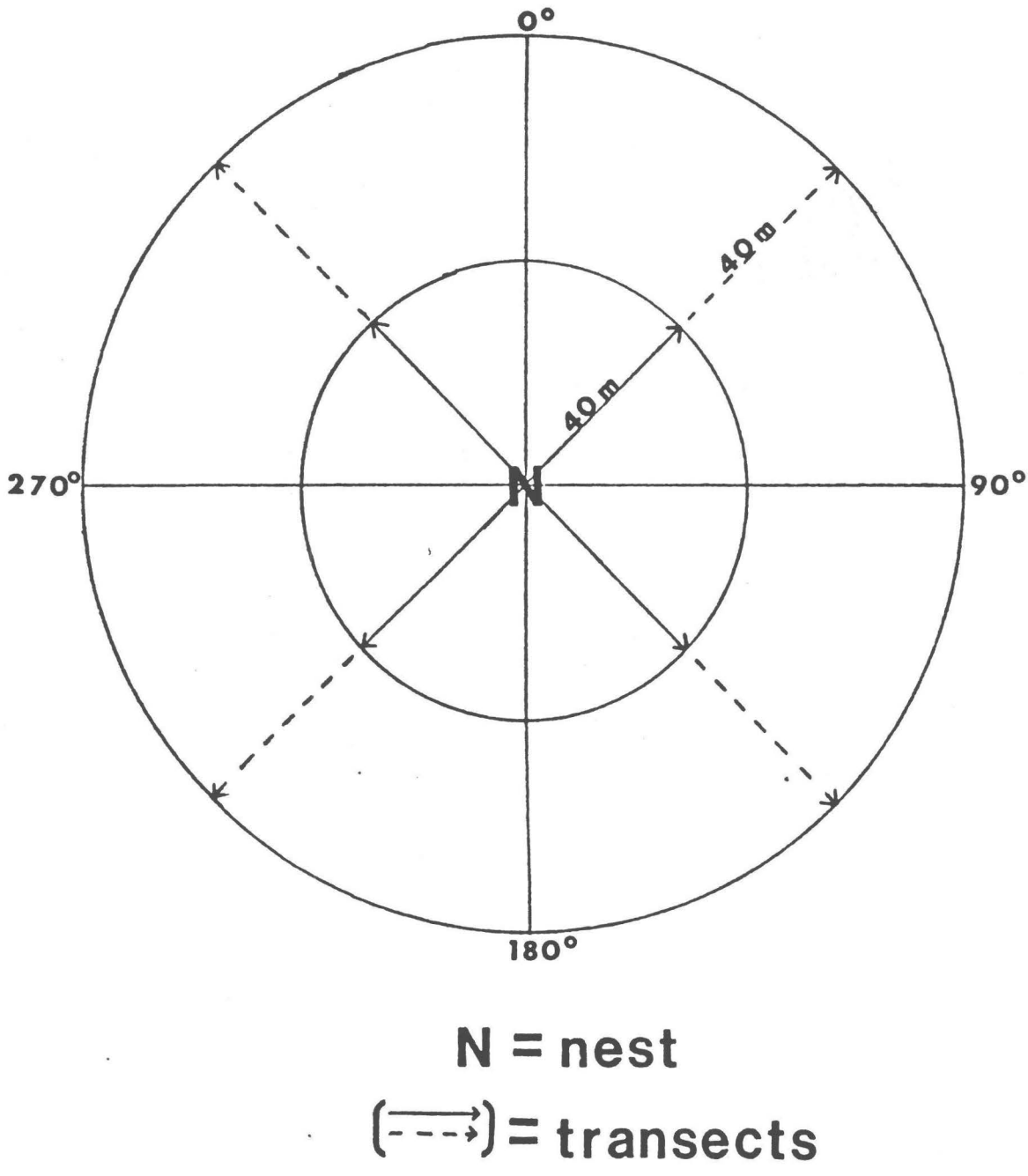

Figure 5. Arrangement of horizontal density board transects around the nest, 1981 and 1982.

occurred consistently and were considered highly palatable (Pieper 1978). Actual height/weight ratios were determined by clipping ungrazed plants into segments and weighing each clipped portion (Crafts 1938). Because of the limitations of this method due to variable site productivity (Caird 1945, Clark 1945), calculated percentages were considered to be merely reflective of grazing pressure and not absolute measurements of forage utilization. Importance indices of plant species (James and Shugart 1970) at brood sites were calculated by summing composition and frequency percentages for all brood site transects.

All observations of radio-tagged hens with poults were plotted on grazing allotment maps and average minimum home ranges calculated. Minimum home range for all broods was considered to be a circle with a common radius. The radius was calculated by averaging the furthest distance traveled from the nest by each brood according to a weighted mean determined by the number of observations for each brood (Svedarsky 1979). The percentage of grazed and rested allotments available within each brood's home range was then compared with frequency of observations in each allotment to determine the influence of grazed versus rested pastures on brood movement and habitat preference.

Habitat type availability was determined from 1/2400 scale quadrangle maps of vegetation types. Brood use was determined by the frequency of observations within each habitat type.

Twelve radioed hens with poults provided 106 brood rearing sites and 37 sites were obtained from chance observations. Due to the visibility bias associated with nonradioed observations, a visibility correction factor based on percent canopy cover was used whenever radioed and nonradioed observations were to be considered as one sample (Eberhardt 1968).

Roost Sites

Roosts were located by tracking radioed birds at night, finding dropping accumulations while in the field and from reports of local hunters. Slope and exposure were recorded and intensive measurements taken for all trees utilized as roosts. Height, dbh, age, vigor, crown class (Keen 1936) and height of lowest limb were recorded for each tree. Canopy cover and BA were measured and past logging activity estimated by the BA of cut stumps at the roost site. Habitat was typed and distances to nearest water, road and opening determined as before. The number of birds using the roost, frequency and season of use were recorded when possible.

Food Habits

For the food habits portion of this study, a microhistological analysis of fecal material was utilized using the procedures of Holechek and Gross (1982) and Holechek and Vavra (1981).

Fecal samples were collected from radio tagged birds (during the course of tracking) and from chance findings of droppings. The fecal samples were collected on a year round basis and were categorized by season. The samples were further categorized as to whether they were found in rested or grazed allotments.

Composite samples were formed from droppings found in the same categories, i.e. one composite sample for droppings found during the summer in rested allotments, and so on.

Twenty-five slides per composite sample were prepared according to Sparks and Malechek (1968). This allowed for 50 slides per season.

All slides were "read" giving frequency and composition estimates of food items eaten by wild turkeys in this area.

Crops and gizzards were collected from gobblers harvested during the 1981, 1982, and 1983 spring hunting seasons. Envelopes and plastic sacks were distributed to hunters at various New Mexico Wild Turkey Federation annual and chapter meetings. Food habits were determined by laboratory analyses (Korschgen 1980). Each food item was identified, measured volumetrically, and recorded.

Insect Sampling

During the summer season of 1982, insect biomass was sampled on grazed and rested allotments to determine if there were any differences in insect production. Insect production could affect brood-rearing site selection by turkeys.

Two areas were selected for sampling in both grazed and rested allotments for a total of 4 sample sites. Each site was sampled 2 times during the summer season beginning in June and terminating in August. Each sampling period lasted for 2 days.

Sampling was done with a D-Vac, Model 1-A, Vacuum Sampler (Dietrick et al. 1960). The sampling procedure used was a modified version of the procedure used by Johansen (1981). Within each sampling area two 100 yard (91.4 m) transects were set up. One transect was set up in "header" canyons and the other in the main canyon bottom or "riparian zone." The header canyons were more indicative of brood-rearing sites (based on previous experience) and the riparian zones were more heavily grazed than the headers. In this way any differences could be determined between as well as within sampling areas.

Each 91.4 m transect consisted of a string stretched between 2 stakes. The vacuum sampler was used along each transect, the suction end was held approximately 10 cm above the ground. At the end of the the transect the collection bag was removed while the sampler was still running to prevent loss of insects due to loss of suction.

Each sample was bagged, tagged, and frozen. They were then taken to the lab where the insects were sorted from the detritus in the sample. The insects were then oven dried for 24 hours at 60°C and weighed.

Statistical Analysis

For data subject to statistical analysis, a nonparametric Mann-Whitney test and the parametric chi-square test were used. Sample size and nature of the data were considered when deciding which test procedure was the more appropriate. Other parametric tests used included the binomial distribution, paired sample *t*-test and a Goodness of Fit test for angular dispersion (Zar 1974). Standard deviations are given for each sample mean ($\bar{x} \pm SD$).

RESULTS

Nesting Habitat

Thirty-eight nests were located over 4 breeding seasons. Thirty-four nests were located by use of radio telemetry and 4 nests were from chance findings. Sixty-eight percent (n = 26) of the nest sites were found in mixed conifer stands (Figure 6) at or approaching climax condition. Fourteen nests were situated in the white fir-Douglas fir/Gambel oak HT[2], 8 in the white fir-Douglas fir/Rocky Mountain maple HT, and 4 nests in the blue spruce/bluegrass HT.

Thirty-two percent (n = 12) of the nests were located in fire seres that were typed according to existing successional vegetation. Four nests occurred in the ponderosa pine/wavy leaf oak ST[3] (Figure 7), 2 in aspen ST (Figure 8), 2 in Gambel oak ST (Figure 9), and 3 in pinyon-juniper/wavy leaf oak ST. One nest was located in the transition zone between an aspen seral type and a dry meadow habitat type.

Many nests occurred in grazed allotments, but were inaccessible to livestock due to rugged topography and dense shrub understories. Only 3 nests were located where cattle had grazed in the immediate vicinity (Figure 10). No nests were found in the dry meadow habitat type, grazed and ungrazed.

Most nests were found on mesic exposures (22) as opposed to xeric exposures (16) (Figure 11). Also, most nests were located on moderately steep slopes ($\bar{x}$ = 46% ± 16) even though level topography was often available nearby. Overstory canopy cover at most nests was higher than

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[2]HT = Habitat type.

[3]ST = Seral type.

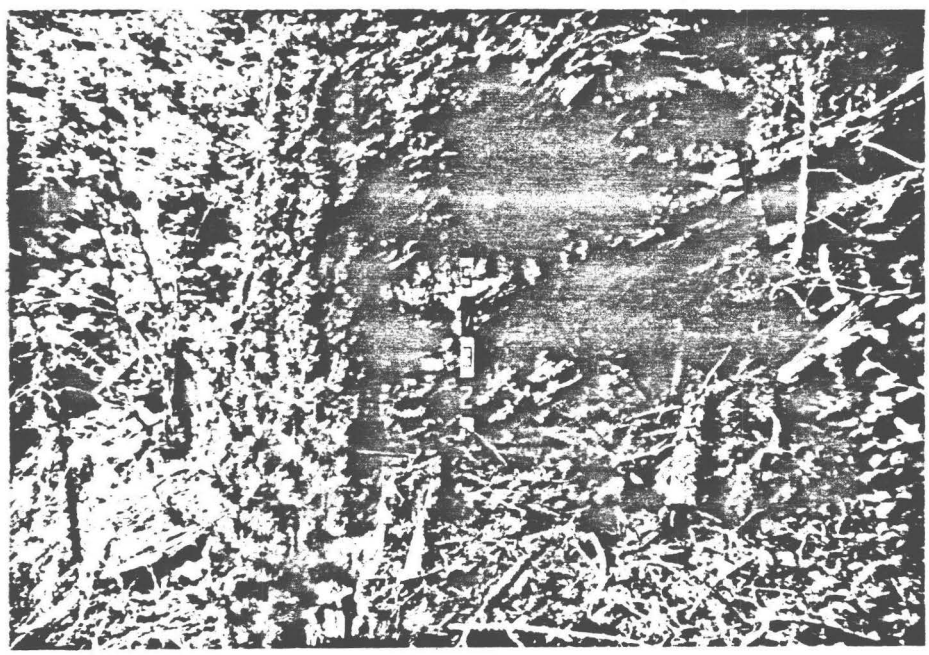


Figure 6. Turkey nest in mixed conifer vegetation on steep mid slope, Logan Canyon, June 21, 1980.

Figure 7. Turkey nest in dense pine-oak vegetation, Scott Able Canyon, July 3, 1980.

Figure 8. Turkey nest in aspen stand, Schofield Canyon, July, 1982.

Figure 9. Turkey nest in Gambel oak vegetation.

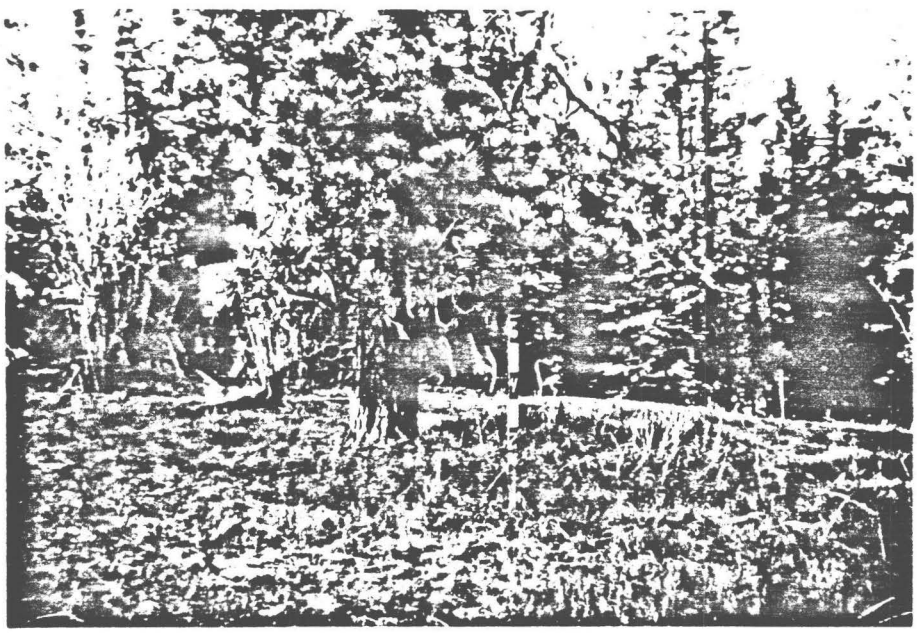
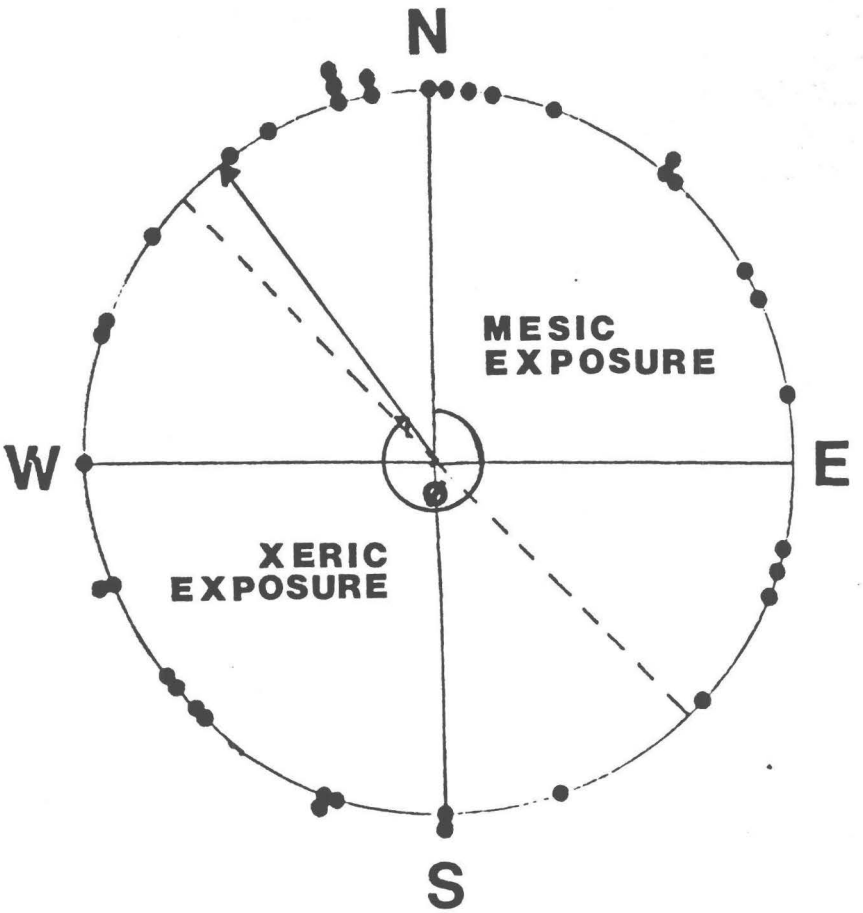


Figure 10. Turkey nest in patch of nettle, Chippeway Park area, June 2, 1980.



n = 38
● = NEST

Ø = 323°
S = 114.3°

Figure 11. Nest site selection according to exposure (ø = mean angle, s = angular deviation).

that of the surrounding stand (Table 1) and ranged from 0% to 100% ($\bar{x}$ = 75% ± 20.5).

Horizontal cover density was consistently high at the 0 - 0.3 m interval (Figure 12). This trend was consistent at all 4 distances from the nest site (Appendix C). The cover was provided by logging slash (Figure 13), shrubs (Figure 14), downed logs, or contour effects.

Timber densities varied widely from a low 10 ft^2/acre (2 m^2/ha) in the pinyon-juniper/wavy leaf oak ST to a high of 340 ft^2/acre (77 m^2/ha) in a thick aspen ST (Table 2). Distances to nearest water ranged from 27 m to 1.9 km ($\bar{x}$ = 617 m ± 453), to nearest road from 9 m to 4.7 km ($\bar{x}$ = 721 m ± 966 m), and to nearest opening from 0 to 1.6 km ($\bar{x}$ = 211 m ± 378). Nest sizes averaged 35.3 cm ± 4.2 cm in length and 27.9 cm ± 5.6 cm in width.

Nesting Success

A total of 56 radio-tagged hens were monitored during the 4 nesting seasons of this study. Of these 56 hens, 29 were adults and 27 were immatures. Seventy-six percent of the adult hens and 11% of the immature hens nested. Nesting success was highest in 1979 and 1982 (37%) and lowest in 1981 (22%) (success = number nest hatched ÷ number of nests x 100). Overall nesting success was 31% (Table 3). For the 4 years of the study, 27% of the potential renesters did so.

Predation claimed 31% of all nests over this 4 year period. Raccoons, skunks, mountain lions, coyotes, and an unknown mammal were responsible.

Of 30 hens that nested during this period, 13 produced broods, or 43% of those hens that nested did so successfully. Due to renesting,

Table 1. Differences in canopy cover at the nest and average canopy cover of surrounding area.

Nest	Percent Canopy Cover		
	Above Nest	Average Around Nest	Difference
1	52	70	-18
2	93	65	28
3	53	45	8
4	73	51	22
5	87	57	30
6	53	--	--
7	68	47	21
8	86	53	33
9	95	81	14
10	48	40	8
11	85	54	31
12	77	24	53
13	61	45	16
14	86	57	29
15	60	72	-12
16	78	68	10
17	77	58	19
18	87	68	19
19	59	63	-4
20	74	48	26
21	91	48	43
22	85	65	20
23	56	60	-4
24	88	82	6
25	79	75	4
26	67	56	10
27	0	30	-30
28	54	68	-14
29	65	78	-13
30	59	80	-21
31	91	91	0
32	97	70	27
33	100	70	30
34	75	61	14
35	100	69	31
36	99	67	32
37	100	38	62
38	100	96	4
	$\bar{x}$ = 75.0	$\bar{x}$ = 61.3	

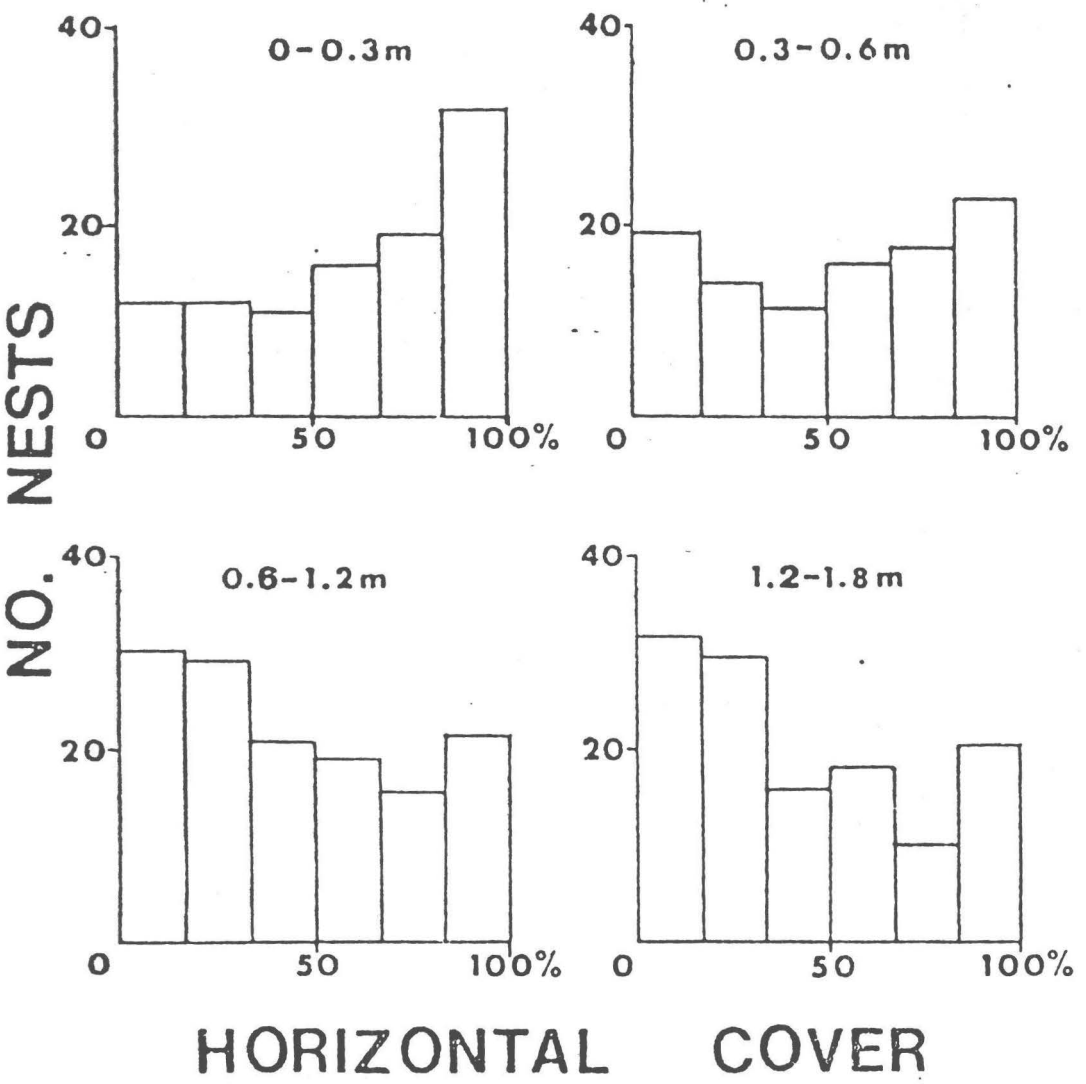


Figure 12. Distribution of horizontal cover around nests at different above ground heights, 10 m from nest (cover categories: 0-9%, 10-24%, 25-49%, 50-74%, 75-90% and 91-100%).

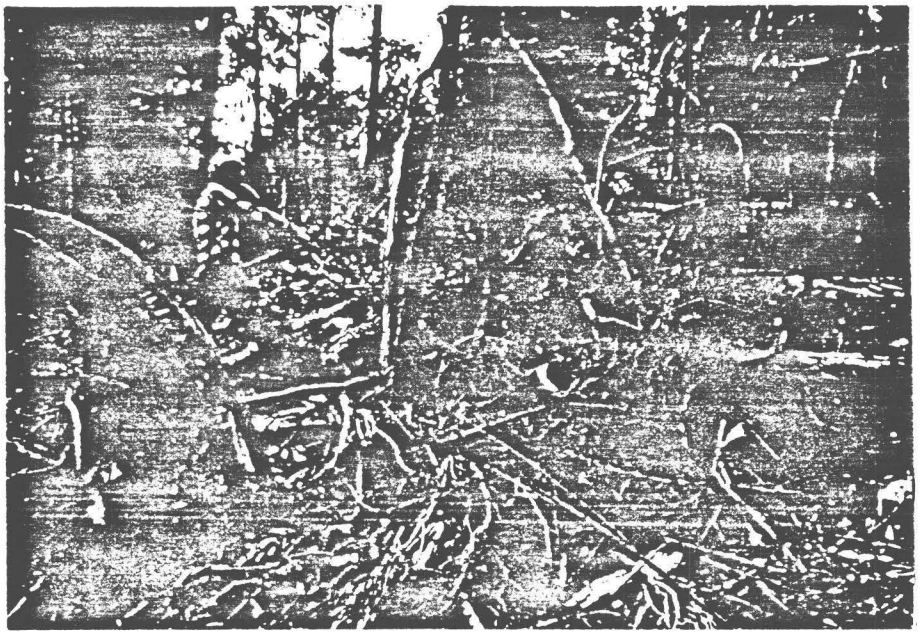


Figure 13, Turkey nest in logging slash, Benson Ridge, June 23, 1979.

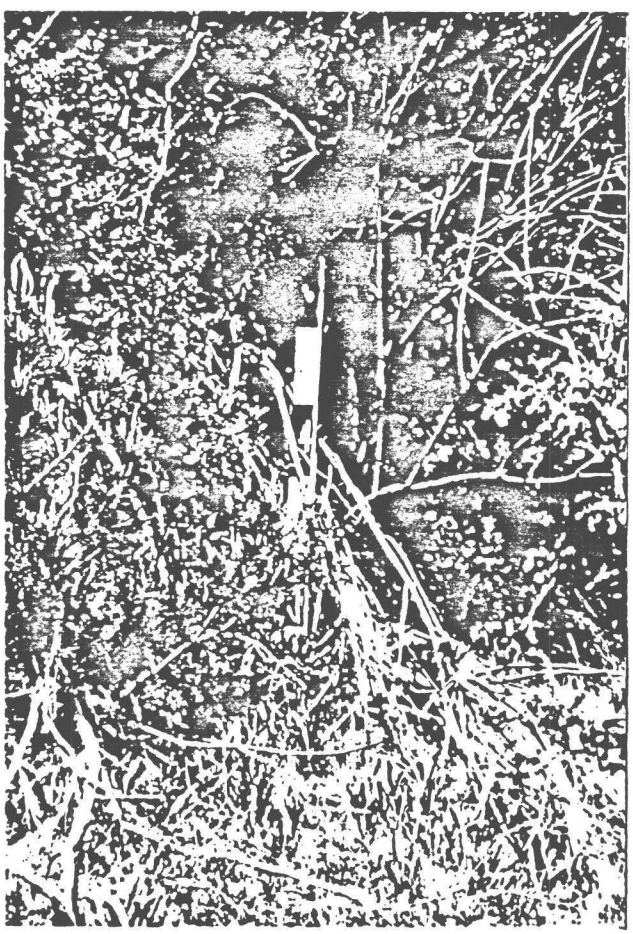


Figure 14. Turkey nest in shrubs (elderberry, ocean spray) on edge of dry meadow, south of Newman Canyon, June, 1982.

Table 2. Timber densities at nest sites.

Habitat Type	Number of Nests	Average Basal Area ft^2/acre	Standard Deviation	Range
White Fir-Douglas Fir/Rocky Mountain Maple	8	146 (33)*	73 (16)	40 - 250 (9 - 56)
White Fir-Douglas Fir/Gambel Oak	14	110 (25)	40 (9)	60 - 170 (13 - 38)
Blue Spruce/Bluegrass	4	95 (21)	71 (16)	40 - 190 (9 - 43)
Ponderosa Pine/Wavyleaf Oak ST	4	57 (13)	17 (4)	40 - 80 (9 - 18)
Aspen ST	2	295 (66)	64 (14)	250 - 340 (56 - 77)
Gambel Oak ST	2	70 (16)	42 (9)	40 - 100 (9 - 22)
Pinyon-Juniper/Wavyleaf Oak ST	3	77 (17)	58 (13)	10 - 120 (2 - 27)
Transition Zone	1	40 (9)	-- (--)	-- (--)

* m^2/ha.

Table 3. Nest success, abandonment, and predation.

Year	Nests	Destroyed by Predators	Abandoned	Hatched	Success
1979	8 (2)*	1	4	3	38%
1980	7 (1)	3	2	2	29%
1981	9 (2)	3	4	2	22%
1982	8 (1)	3	2	3	38%
Total	32 (6)	10	12	10	31%

*Numbers in parentheses indicate renests.

Percent hatching = 31
Percent destroyed = 31
Percent abandoned = 38
100

Average clutch size = 8.6 ± 2.1
Fertility rate = 66%

nesting success on a per nest basis was less (26%). Average clutch size was 8.6 ± 2.1 eggs per nest and ranged from 4-13.

The fertility rate for all eggs was 66%. Many of the abandoned nests contained completely infertile eggs. In the first 2 years of the study the fertility rate for all eggs was only 48% and in many instances was responsible for the hatching failure of entire clutches. During this 2 year period, eggs in 5 of 6 abandoned nests were completely infertile. One nest abandonment left 6 eggs with embryos showing 17 days development and 2 eggs that were infertile.

Nest success was not related to the logging history of timber around the nest (Table 4), nor was nest success related to canopy cover, grazing system, habitat type or other parameters measured.

Brood-Rearing Habitat

Radioed hens with poults provided 106 observations of brood feeding areas. Nonradioed hens with poults provided 37 observations. As mentioned in the Methods section, there was an obvious tendency for nonradioed observations to be biased toward lighter canopy covers (Figure 15) due to the increased visibility afforded by more open situations (i.e. meadows). By adjusting the nonradioed observations according to the distribution of radioed observations along canopy cover gradients, the 2 samples were combined (n = 143). Small, logged openings along ridge tops (average area = 0.48 ha ± .37), saddles, heads of canyons, and borders of larger meadows were used repeatedly. Forty-nine percent of the brood sites located were found on the upper 1/3 of the slope to ridge tops, 20% on the middle 1/3 of the slope and 31% on the lower 1/3 to bottom of the slope.

Table 4. The effect of logged versus unlogged timber on nest success.

	Successful Nests	Unsuccessful Nests	Total
Selectively Logged	6	9	15
Unlogged	7	15	22
Total	13	24	37

Chi square test: The success or failure of nests was not due to logging activity, $\chi^2_{0.05,1}$ $(0.1 < P < 0.25)$.

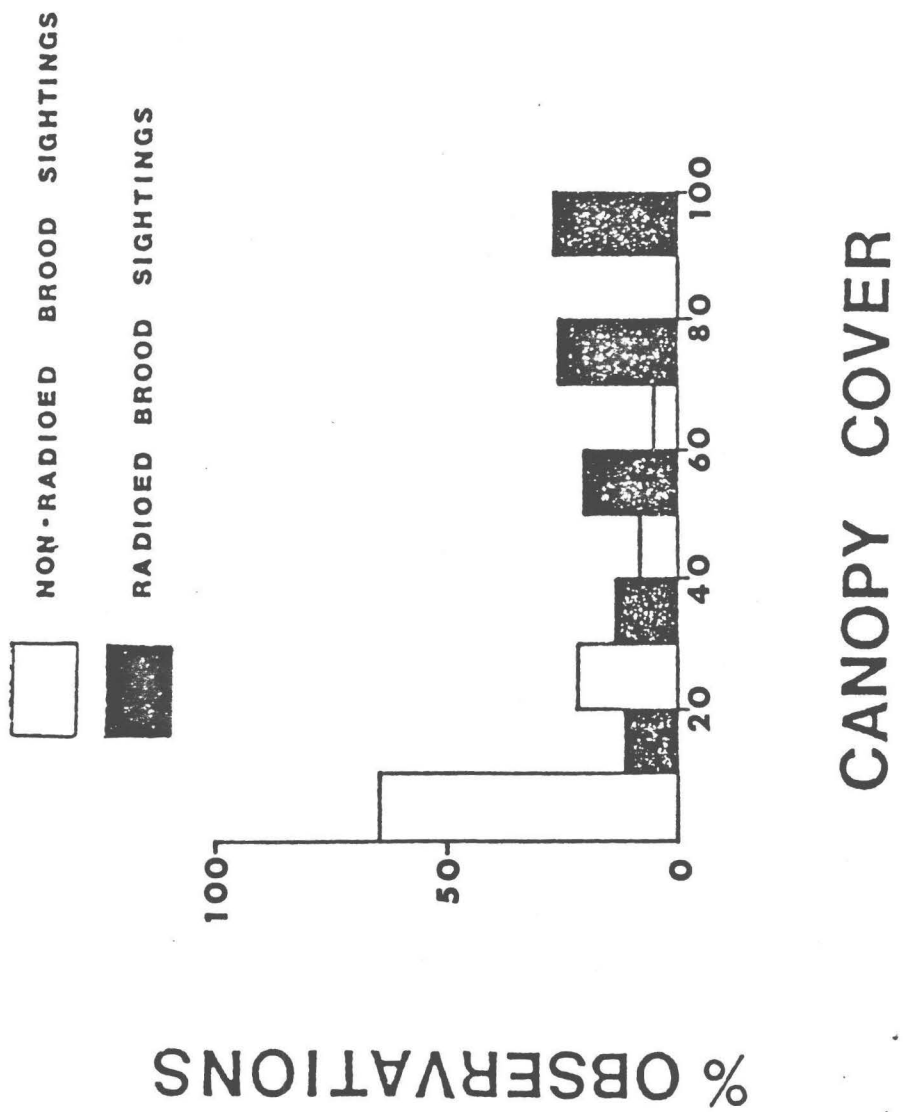


Figure 15. Visibility bias associated with non-radioed brood observations.

No broods were ever observed more than 30 m from overstory cover. Logged mixed conifer habitat types (Figures 16, 17), meadows, and aspen glens (Figure 18) were the most utilized habitats (Figure 19). Slope aspects at brood sites were random, while slopes ($\bar{x}$ = 18.5% ± 13.3) and canopy cover ($\bar{x}$ = 48% ± 35.8) were less than that found at nest sites.

Seven hens with broods had access to both rested and grazed pastures. Seventy-five percent (60) of the brood observations, within the rest-rotation grazing system, were in grazed pastures and 25% were in rested pastures (Table 5). Due to the low number of brood ranges exclusively in the continuous system (n=3) no real comparisons could be made between the two systems. Minimum common home ranges for broods were 22.1 km^2 (circle with r = 2.65 km).

Grazing utilization at the brood sites, inferred from bluegrass heights, varied from 0-70% and averaged 25.5%. On the average, however, there was no significant difference between brood site grass heights when compared between rested versus grazed pastures ($\bar{x}$ Poa sp. height grazed = 8.4 inches and $\bar{x}$ Poa sp. height rested = 7.7 inches) (Figure 20). Average Poa sp. height for brood sites within the continuous system was 5.8 inches.

When broods were observed in mixed conifer habitat types, they used small logged openings exclusively. Logging intensity averaged 52% of BA removed per brood site, with an average stump basal area of 9 m^2/ha.

Plant species have been ecologically classified as decreasers, increasers, or invaders (U.S. For. Serv. 1979), according to the manner in which they respond to grazing or other disturbance. When

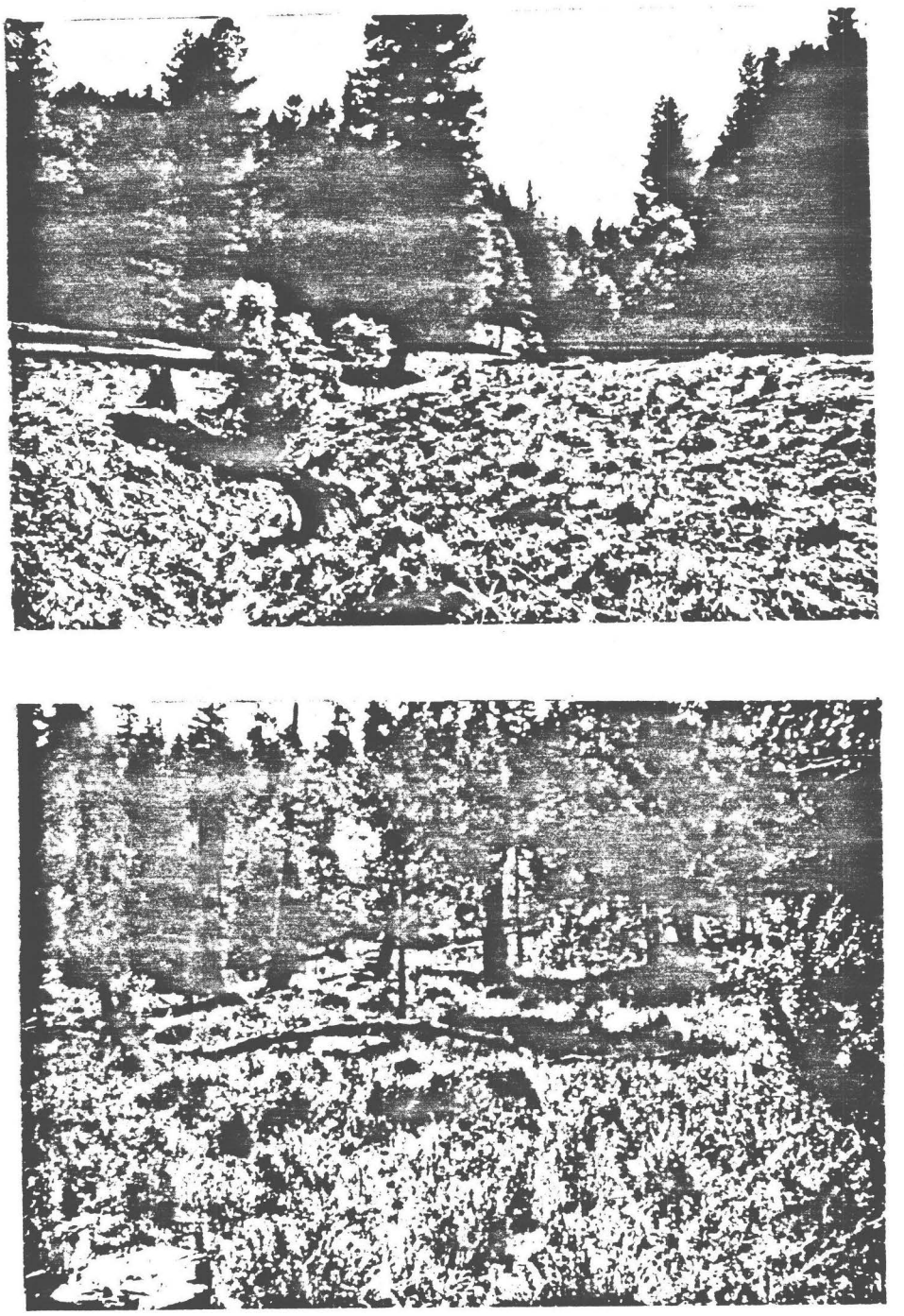


Figure 16. (top) A typical grazed opening seldom used by turkey hens and poults as summer brood habitat, SW¼, Sect. 32, T15S, R13E, 2 miles west of Cloudcroft, June 1980. (bottom) Logged, ungrazed, small opening used by turkey hens and poults as brood habitat, ridgetop, Schofield Canyon, June 2, 1979.

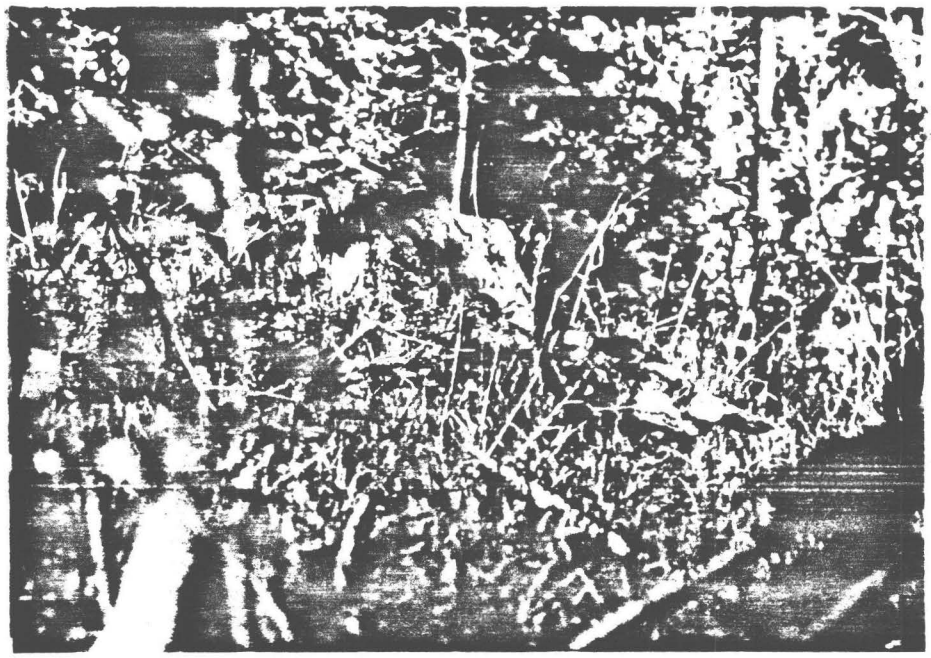


Figure 17. Radio-tagged hen with brood in typical brood habitat, Little Hay Canyon, June 28, 1980.

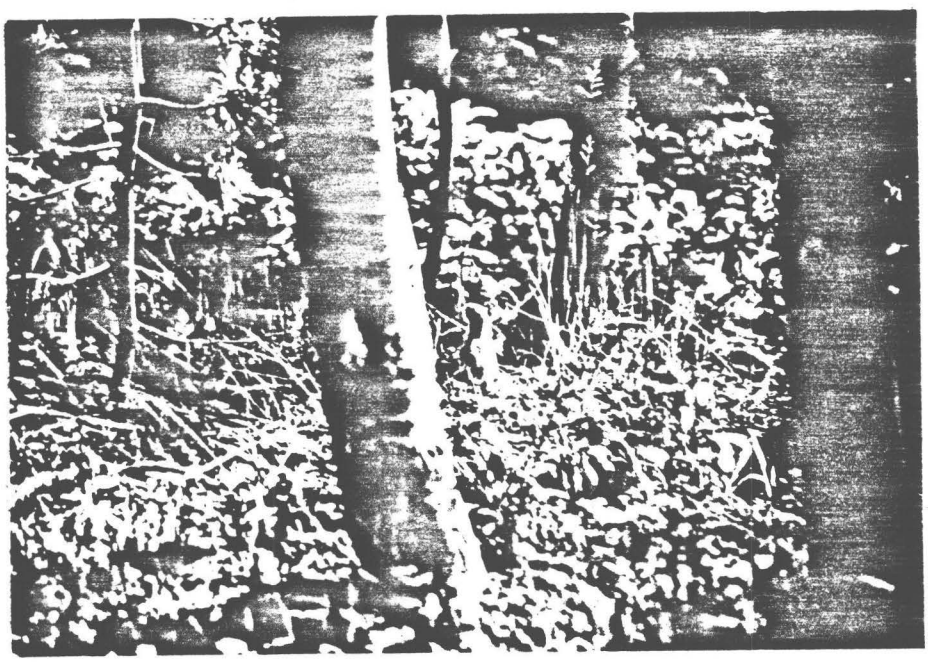


Figure 18. Day-old turkey poult in aspen vegetation, Benson Canyon, June 22, 1982.

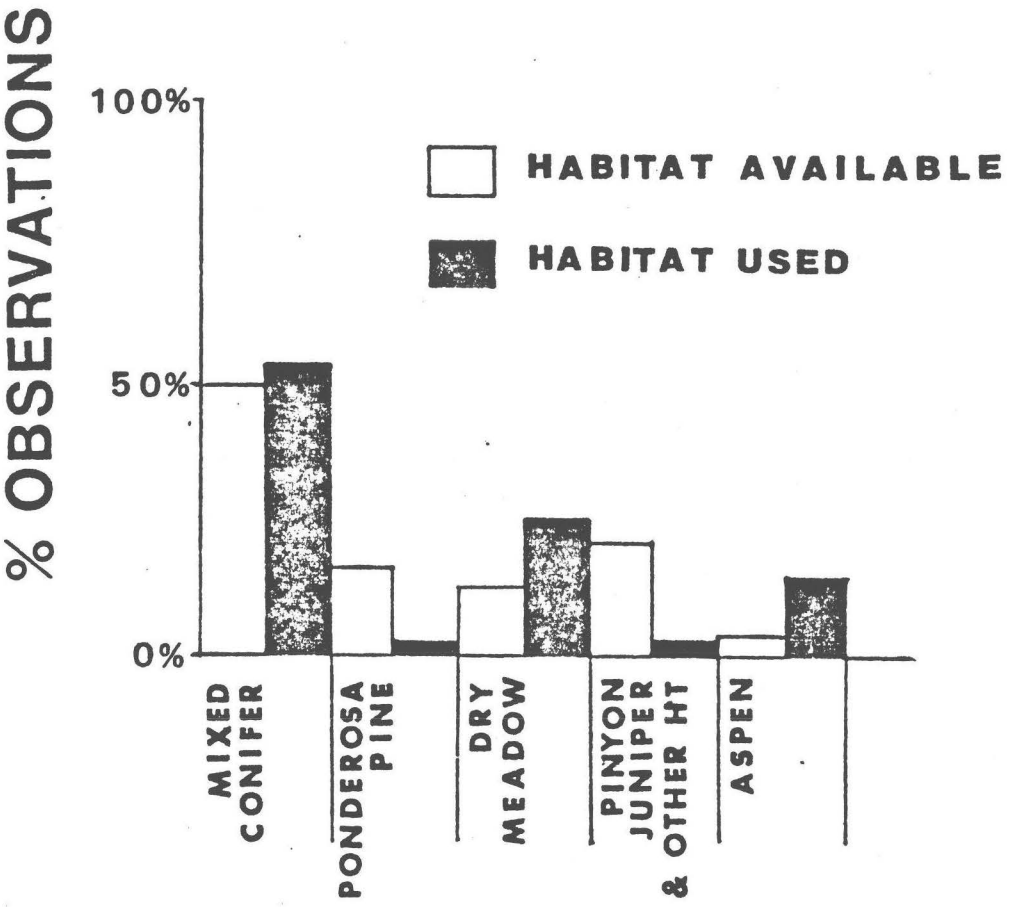


Figure 19. Brood use of available habitat types.

Table 5. Brood use of rested versus grazed pastures within the rest-rotation grazing system.

	Grazed	Rested	Total
Observed	60	20	80
Expected	56	24	80

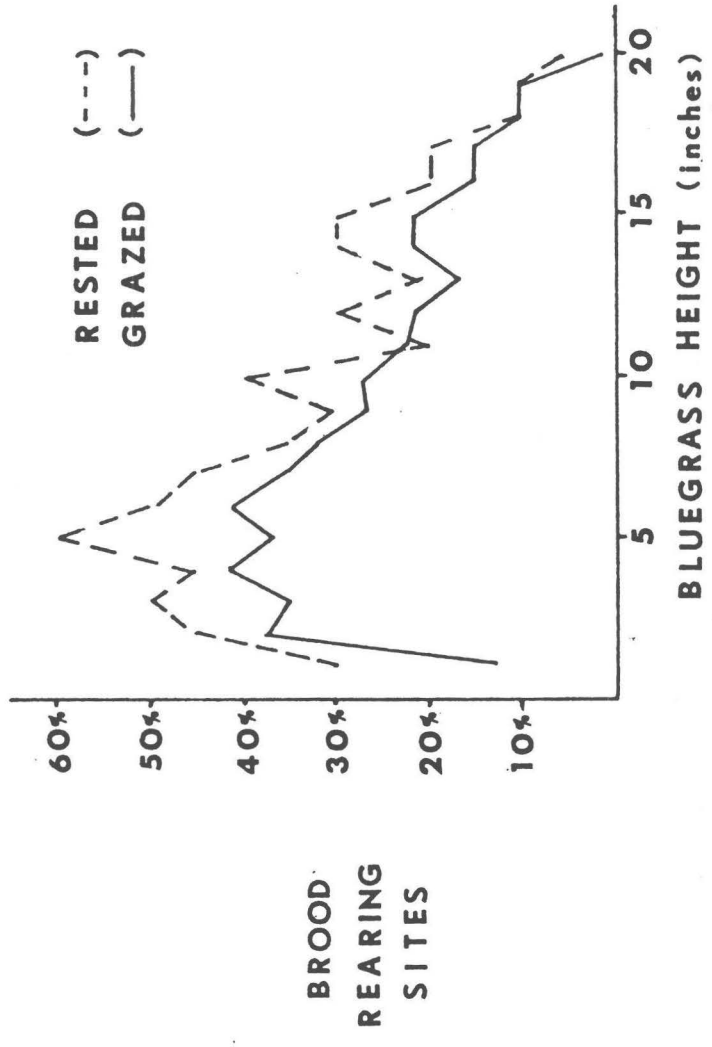


Figure 20. Comparison of grass heights at brood sites between rested and grazed pastures.

the indices for these ecological categories of brood site vegetation were compared (Tables 6, 7, 8, 9), the majority (60%) of important plants were increaser or invader type species. Neither composition, cover, or height of vegetation varied significantly between brood sites located in grazed versus rested pastures. Distances to nearest water averaged 619 m ± 467 m and 400 m ± 384 m to nearest road. All brood sites were in or adjacent to openings in the forest canopy.

Brood-Rearing Success

Because of poor nesting success, only 4 broods were available for tracking during the first 2 years of the study (the fifth hen with poults lost her transmitter the day of hatching). Two broods were tracked in 1979 and 2 in 1980. Eighty-one percent of the 1979 poults survived the summer, but all the 1980 poults were eventually lost to unknown causes. In 1981, 5 broods were available for tracking with 84% of the poults surviving the summer. In 1982, 3 broods were tracked, with 45% of the poults surviving the summer season.

Roosting Habitat

Twenty-nine "winter" (roosts used October through May) roosts and 22 summer roosts were located over 4 years. Winter roosts differed from summer (roosts used June through September) roosts in size, number of trees used, exposure, distance to nearest water and recurrent use by turkeys. Winter roosts were larger with more trees utilized (Table 10), located on easterly exposures (Figure 21), were closer to water ($\bar{x}$ = 322 m ± 215) and used repeatedly by larger flocks over several weeks to months. Summer roosts (Figure 22) were smaller, randomly

Table 6. Importance values and ecological classifications of grasses at brood sites based on frequency of occurrence and percent composition (importance = occurrence + composition).

Species	Class	Percent Occurrence	Percent Composition	Importance Index
Poa pratensis	Increaser	52	27.0	79.0
Poa sp.	Increaser	30	7.0	37.0
Bromus anomalus	Decreaser	28	4.0	32.0
Bromus sp.	Decreaser	22	2.0	24.0
Poa fendleriana	Increaser	18	3.0	21.0
Bromus inermis	Increaser	17	2.0	19.0
Bromus ciliatus	Increaser	16	2.0	18.0
Stipa robusta	Invader	17	1.0	18.0
Agropyron sp.	Decreaser	12	1.2	13.2
Carex sp.	Increaser	12	1.0	13.0
Dactylis glomerata	Decreaser	9	1.0	10.0
Sitanion hystrix	Increaser	6	0.5	6.5
Festuca arizonica	Decreaser	6	0.5	6.5
Stipa pringlei	Invader	3	0.2	3.2
Bouteloua gracilis	Increaser	3	0.1	3.1
Agrostis alba	Increaser	3	0.07	3.07
Agropyron cristatum	Decreaser	2	0.1	2.1
Agropyron smithii	Decreaser	2	0.07	2.07
Agropyron trachycaulum	Decreaser	2	0.07	2.07
Koelaria cristata	Decreaser	1	0.1	1.1
Avena fatua	Unclassified	1	0.07	1.07
Muhlenbergia montana	Decreaser	1	0.03	1.03
Elymus sp.	Decreaser	1	0.03	1.03
Lolium perenne	Increaser	1	0.03	1.03
Aristida sp.	Invader	1	0.01	1.01
Sporobolus sp.	Invader	1	0.01	1.01
Eragrostis cilianensis	Invader	1	0.01	1.01
Unknown Grasses	Unclassified	26	1.0	27.0

Table 6. Continued.

Species	Class	Percent Occurrence	Percent Composition	Importance Index
Total	Decreaser	86	9.1	95.1
	Increaser	158	42.7	200.7
	Invader	23	1.23	24.23
	Unclassified	27	1.07	28.07

Table 7. Importance values and ecological classifications of herbaceous species at brood sites based on frequency of occurrence and percent composition (importance = occurrence + composition).

Species	Class[a]	Percent Occurrence	Percent Composition	Importance Index
Achillea lanulosa	Invader	61	5.0	66.0
Fragaria bracteata	Increaser	54	4.0	58.0
Taraxacum officinale	Invader	48	3.0	51.0
Artemisia ludoviciana	Invader	45	6.0	51.0
Oxalis sp.	Increaser	47	3.0	50.0
Geranium atropurpureum	Increaser	46	3.0	49.0
Vicia americana	Decreaser	45	3.0	48.0
Erigeron sp.	Invader	42	3.0	45.0
Helenium hoopesii	Invader	40	3.0	43.0
Galium sp.	Invader	34	1.0	35.0
Iris missouriensis	Invader	28	1.0	29.0
Lathyrus sp.	Decreaser	26	1.0	27.0
Artemisia franseroides	Invader	24	1.0	25.0
Stellaria sp.	Invader	22	1.0	23.0
Viola sp.	Decreaser	21	2.0	23.0
Senecio salignus	Invader	17	1.0	18.0
Trifolium sp.	Decreaser	15	1.0	16.0
Rudbeckia laciniata	Invader	14	1.0	15.0
Senecio sp.	Invader	14	1.0	15.0
Cirsium sp.	Invader	13	0.5	13.5
Senecio wootnii	Invader	13	0.4	13.4
Medicago sp.	Decreaser	12	1.0	13.0
Galium boreale	Invader	12	1.0	13.0
Smilacina sp.	Unclassified	11	0.5	11.5
Pseudocymcopterus montanus	Unclassified	11	0.4	11.4
Prunella vulgaris	Unclassified	11	0.3	11.3
Gentiana sp.	Invader	9	1.0	10.0

[a]U.S. For Serv. (1979).

Table 7 . Continued.

Species	Class[a]	Percent Occurrence	Percent Composition	Importance Index
Cerastium arvense	Invader	9	0.3	9.3
Pachystima myrsinites	Unclassified	8	0.4	8.4
Actaea rubra	Unclassified	7	0.1	7.1
Urtica sp.	Invader	5	0.4	5.4
Allium sp.	Invader	5	0.3	5.3
Erigeron subtrinervis	Invader	5	0.1	5.1
Potentilla sp.	Invader	5	0.05	5.05
Solidago missouriensis	Invader	3	0.1	3.1
Grindelia squarrosa	Invader	3	0.1	3.1
Aquilegia sp.	Decreaser	3	0.06	3.06
Smilacina stellata	Unclassified	3	0.06	3.06
Chenopodium album	Invader	3	0.06	3.06
Verbascum sp.	Unclassified	3	0.06	3.06
Eriogonum sp.	Invader	2	0.3	2.3
Conopholis mexicana	Unclassified	2	0.06	2.06
Swertia palustris	Unclassified	2	0.06	2.06
Mentha sp.	Invader	2	0.06	2.06
Senecia mexicanus	Invader	2	0.02	2.02
Cosmos parvifolia	Unclassified	1	0.1	1.1
Oenothera sp.	Invader	1	0.06	1.06
Medicago hispida	Increaser	1	0.06	1.06
Erysimum sp.	Invader	1	0.06	1.06
Polemonium sp.	Invader	1	0.02	1.02
Tragopogon major	Unclassified	1	0.02	1.02
Verbena macdongalii	Invader	1	0.02	1.02
Solanum sp.	Invader	1	0.02	1.02
Smilacina racemosa	Unclassified	1	0.02	1.02
Campanula rotundifolia	Increaser	1	0.02	1.02

[a]U.S. For. Serv. (1979).

Table 7 . Continued.

Species	Class[a]	Percent Occurrence	Percent Composition	Importance Index
Agustache cana	Unclassified	1	0.01	1.01
Arenaria sajanensis	Invader	1	0.01	1.01
Aster sp.	Invader	1	0.01	1.01
Valeriana sp.	Unclassified	1	0.01	1.01
Daucus pusillus	Unclassified	1	0.01	1.01
Penstemon sp.	Invader	1	0.01	1.01
Castilleja sp.	Increaser	1	0.01	1.01
Aesclepias sp.	Invader	1	0.01	1.01
Equisetum sp.	Unclassified	1	0.01	1.01
Unknown Forbs	Unclassified	28	0.7	28.7
Total	Decreaser	96	7.06	103.06
	Increaser	176	11.09	187.09
	Invader	489	31.91	520.91
	Unclassified	93	2.82	95.82

[a]U.S. For. Serv. (1979).

Table 9. Importance values of all vegetation at brood sites.

Class	Grasses	Forbs	Shrubs	Total	Percent
Decreasers	95.1	103.06	--	198.16	12
Increasers	200.7	187.09	--	387.79	25
Invaders	24.23	520.91	--	545.14	35
Unclassified	28.07	95.82	312.4	436.29	28
Total	348.1	906.88	312.4	1567.38	100

Table 8 . Importance values of shrubs and small trees at brood sites based on frequency of occurrence and percent composition (importance = occurrence + composition).

Species	Percent Occurrence	Percent Composition	Importance Index
Quercus gambelii	38	11.0	49.0
Robinia noemexicana	28	5.0	33.0
Holodiscus dumosus	24	8.0	32.0
Thalictrum sp.	26	2.0	28.0
Populus tremuloides	19	4.0	23.0
Ribes sp.	17	2.0	19.0
Pseudotsuga menziesii	15	0.3	15.3
Sambucus sp.	13	2.0	15.0
Rubus sp.	13	1.0	14.0
Rosa fendleriana	12	2.0	14.0
Abies concolor	12	0.4	12.4
Clematis ligusticifolia	9	0.6	9.6
Acer glabrum	9	0.3	9.3
Brickellia grandiflora	8	0.4	8.4
Symphoricarpos alba	6	2.0	8.0
Opulaster sp.	5	0.1	5.1
Prunus sp.	3	0.06	3.06
Cercocarpus sp.	3	0.06	3.06
Pinus ponderosa	3	0.06	3.06
Pinus strobiformis	2	0.02	2.02
Fraxinus sp.	1	0.02	1.02
Jamesia americana	1	0.02	1.02
Acer grandidentatum	1	0.02	1.02
Prunus virginiana	1	0.02	1.02
Picea engelmannii	1	0.01	1.01
Juniperus sp.	1	0.01	1.01
Total	271	41.4	312.4

Table 10. Winter and summer roost differences in number of trees, size of area and utilization.

	Number of Roosts	Average Number of Trees	Average Area	Number Used Repeatedly
Winter	29	8 ± 4.0	0.087 ha (0.21 acres)	29
Summer	22	2 ± 1.36	0.02 ha (0.05 acres)	1

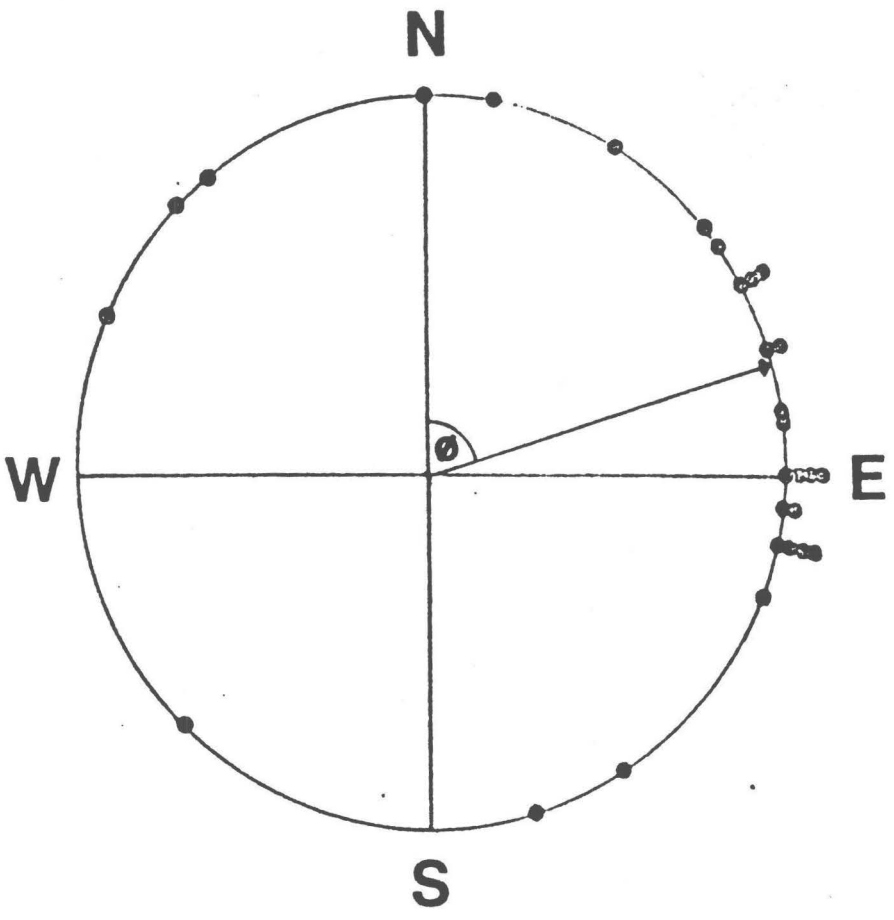


Figure 21. Winter roost selection according to exposure (ø = mean angle, s = angular deviation).

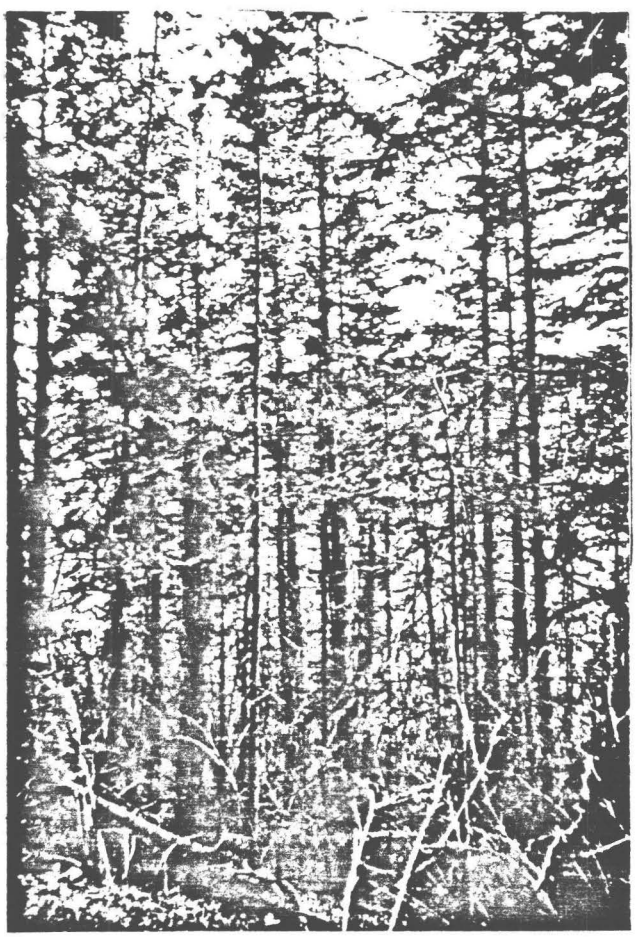


Figure 22. Summer turkey roost in Rice Canyon, June 30, 1980.

oriented with respect to exposure, were farther from water (1670 m ± 727) and rarely used more than once. Roosting habits of hens with poults did not differ from summer roosting habits of hens without poults for any parameter measured.

In both summer and winter roosts, dominant or codominant Douglas and white firs were used almost exclusively, but the largest, overmature trees were not always utilized. Ponderosa pine and southwestern white pine were used occasionally but Gambel oak was never used for roosting. In 2 instances aspen was utilized for roosting.

Mean dbh for winter roost trees was 44 cm ± 16.2 (r = 17.5 cm - 105). Minimum height was 11 m ($\bar{x}$ = 23 m ± 7), ages ranged from 10 to 200+ years ($\bar{x}$ = 91 ± 54). Canopy cover averaged 73.2% ± 13.6 and BA averaged 40.5 m^2/ha ± 16 (174 ft^2/acre). Fifty percent of the winter roost sites had been selectively cut with 5-25 m^2/ha (20-100 ft^2/acre) of BA removed.

The majority of winter roost sites were located in mixed conifer habitat types (Figures 23-25). Fifty-four percent of the roost sites were situated on the upper one-third of the slope to ridgetops, 27% were located on the middle 1/3 of the slope, and 19% were positioned on the lower 1/3 of the slope.

Distance to the nearest permanent water source varied from 9 m to 0.8 km. Average distances to the nearest road and opening were 445 m ± 426 m and 95 m respectively.

Food Habits

A total of 339 slides of fecal samples were used to analyze turkey food habits over the four seasons. Comparisons were made between rested

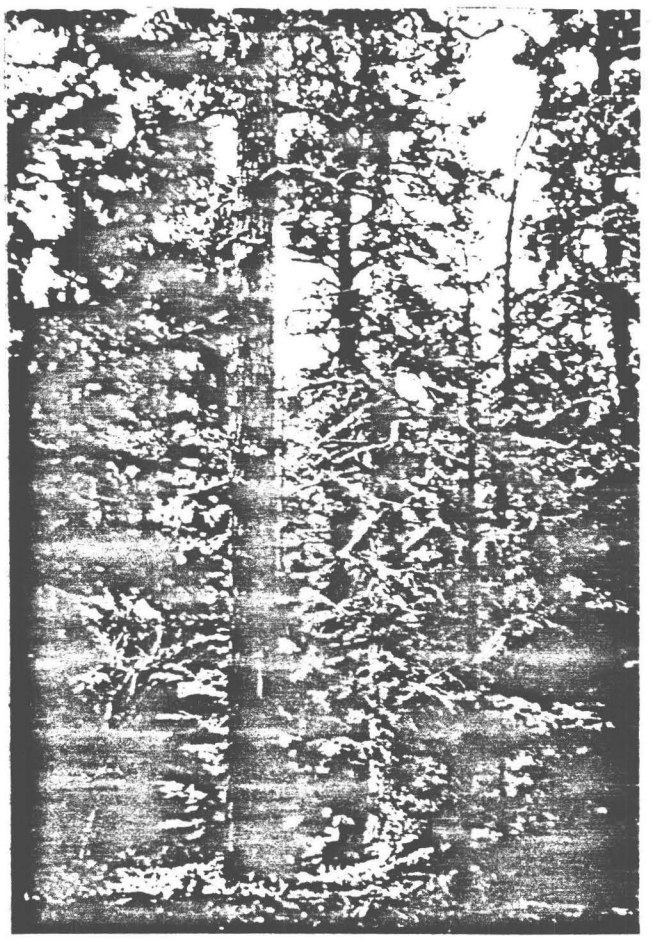


Figure 23. Winter turkey roost consisting of Douglas fir and white fir trees, Moore Canyon, May 12, 1980.

Figure 24. Three adjacent, heavily utilized Douglas fir roost trees showing wide variation in crown densities, Moore Canyon, May 1979.

Figure 25. Ponderosa pine winter roost tree.

and grazed pastures, but no significant differences in types of foods eaten could be found.

During the spring season (April 1 to June 1) grasses such as bluegrass and Arizona fescue and forbs such as dandelion and water cress comprised most of the turkeys' diet. In summer, the bulk of the diet is made up of grasses such as bluegrass. During this season the amount of forbs eaten greatly decreases. Also, summer (June 1 - September 14) is the season when insects appear in the greatest abundance in the diet. The fall season (September 15 - November 31) brings an increase in the number of seeds and berries eaten from such shrubs as currants and elderberry. During the winter season (December 1 - March 30), grasses such as bluegrass and forbs such as watercress are once again major food items in the turkeys' diet (Figure 26, Tables 11, 12, 13, 14).

Crop and gizzard analyses of spring-killed turkeys were similar to the results obtained through fecal analysis. The main spring vegetative foods were found to be dandelion flowers and leaves, bluegrass leaves, juniper berries, and various other grass leaves. These food items comprised 75.3% of the total volume of food consumed (Table 15). Snails were the main animal food eaten. Insects and other animal material comprised 13.1% by volume of the foods eaten.

Turkey gizzards (Table 16) contained many of the same foods found in the crops. Snowberry seeds and cherry pits were found in the gizzards but not in the crops. All gizzards and crops were obtained from adult male turkeys.

Insect Biomass

Insect biomass was the greatest during the month of July. In the "header" canyons, insect biomass was greater than in the riparian zones

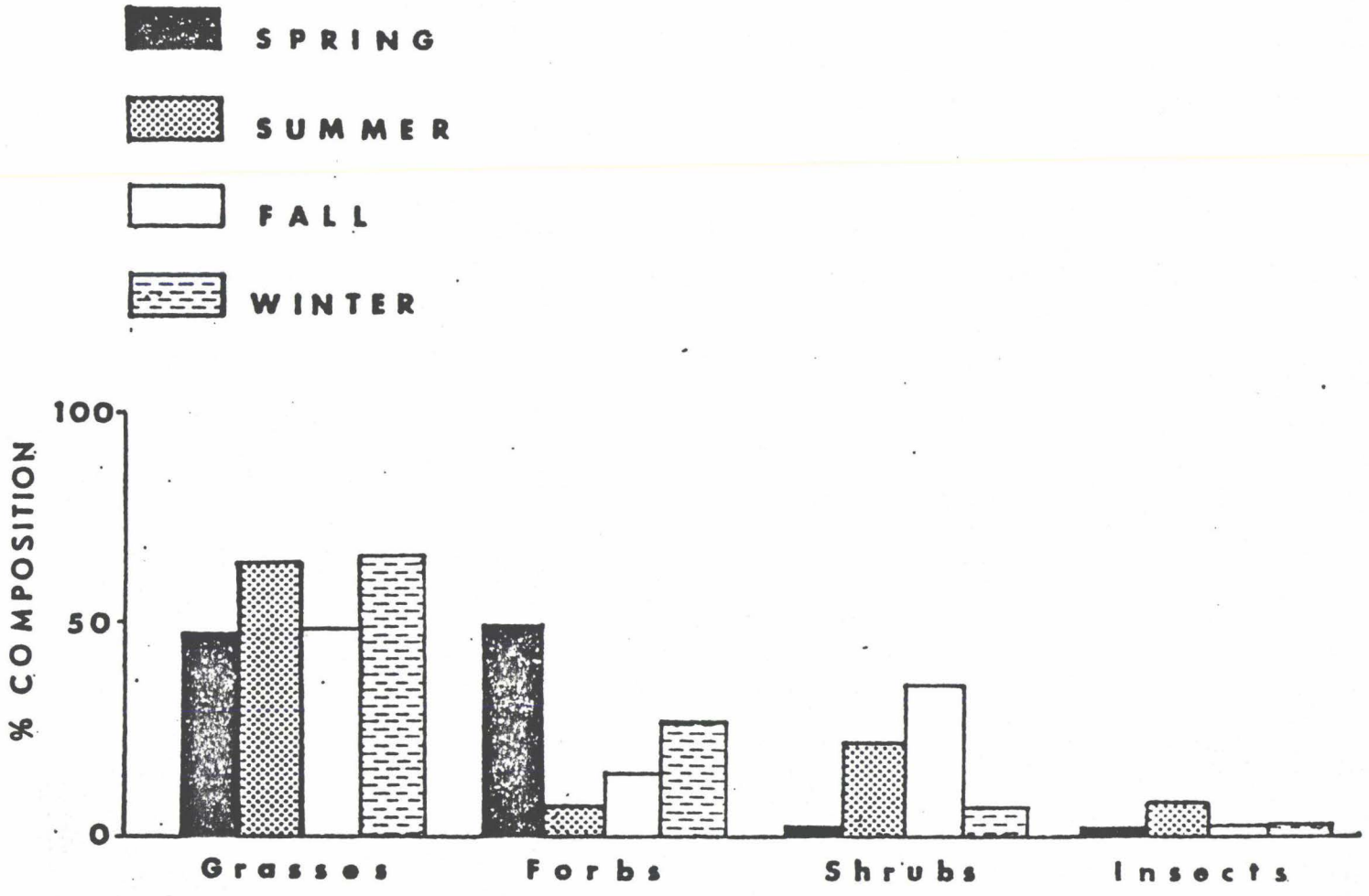


Figure 26. Percent composition of grasses, forbs, and insects found in turkey fecal samples during the four seasons.

Table 11. Percent composition and percent occurrence of food items utilized by turkeys during the spring season, 1979-1982 based on fecal analysis.

Species	Percent Composition*	Percent Occurrence
Taraxacum officinale	48	85
Nasturtium sp.	39	89
Carex sp.	29	67
Poa sp.	25	81
Bromus sp.	24	71
Agrostis alba	6	55
Festuca sp.	4	31
Insect	3	35
Scrophularia sp.	3	35
Rosa fendleriana	2	29
Senecio sp.	2	27
Stipa sp.	1	15
Agropyron sp.	1	3
Osmorhiza sp.	1	11
Geranium atropurpureum	1	16
Muhlenbergia sp.	1	9
Verbascum sp.	TR**	5
Medicago sp.	TR	7
Ribes sp.	TR	8
Sambucus caerula	TR	7
Melilotus sp.	TR	3
Salix sp.	TR	3
Achillea lanulosa	TR	3
Lonicera sp.	TR	1
Clematis neomexicana	TR	1
Erigonum sp.	TR	1
Dactylis glomerata	TR	3
Vicia americana	TR	1

*Percentage of total fields of view (20 per slide).

**Less than 1.0%.

Table 12. Percent composition and percent occurrence of food items utilized by turkeys during the summer season, 1979-1982 based on fecal analysis.

Species	Percent Composition	Percent Occurrence
Festuca sp.	47	94
Poa sp.	16	58
Rosa fendleriana	9	27
Juniperus sp.	8	36
Agrostis alba	8	53
Insect	8	54
Nasturtium sp.	5	42
Bromus sp.	4	15
Holodiscus dumosus	2	20
Robinia neomexicana	2	29
Taraxacum officinale	1	12
Senecio sp.	1	13
Agropyron sp.	1	9
Medicago sp.	1	9
Prunus serotina	TR*	5
Ribes sp.	TR	7
Lolium perenne	TR	3
Elymus canadensis	TR	1
Verbascum sp.	TR	1
Dactylis glomerata	TR	1
Actaea rubra	TR	2
Scrophularia sp.	TR	2
Carex sp.	TR	2
Achillea lanulosa	TR	1
Erodium sp.	TR	1
Pinus flexilis	TR	1
Pinus ponderosa	TR	2
Potentilla sp.	TR	1
Clematis neomexicana	TR	1
Quercus gambelii	TR	5

*Less than 1.0%.

Table 13. Percent composition and percent occurrence of food items utilized by turkeys during the fall season, 1979-1982 based on fecal analyses.

Species	Percent Composition	Percent Occurrence
Ribes sp.	42	84
Bromus sp.	30	62
Nasturtium sp.	19	51
Poa sp.	15	78
Festuca sp.	10	49
Agrostis alba	9	51
Sambucus caerula	4	42
Taraxacum officinale	1	18
Agropyron sp.	1	9
Holodiscus dumosus	1	11
Dactylis glomerata	TR*	9
Plantago sp.	TR	4
Medicago sp.	TR	2
Insect	TR	9

*Less than 1.0%.

Table 14. Percent composition and percent occurrence of food items utilized by turkeys during the winter season, 1979-1982 based on fecal analysis.

Species	Percent Composition	Percent Occurrence
Poa sp.	68	98
Nasturtium sp.	31	83
Ribes sp.	6	50
Agrostis alba	6	51
Bromus sp.	3	27
Festuca sp.	2	27
Taraxacum officinale	1	11
Holodiscus dumosus	1	13
Juniperus sp.	TR*	3
Verbascum sp.	TR	6
Agropyron sp.	TR	6
Clematis neomexicana	TR	1
Robinia neomexicana	TR	6
Prunus serotina	TR	3
Medicago sp.	TR	7
Quercus gambelii	TR	1
Dactylis glomerata	TR	4
Plantago sp.	TR	1
Elymus canadensis	TR	4

*Less than 1.0%.

Table 15. Crop contents of 24 adult male turkeys collected in the Sacramento Mountains, April 1981, 1982, 1983.

Food Item	Vol. (cc)	% Vol.	% Freq.
Taraxacum officinale (flowers)	294.4	36.3	54.2
Poa sp. (leaves)	160.8	19.8	80.0
Juniperus sp. (berries)	115.0	14.2	12.5
Snails	102.0	12.6	8.3
Unknown Grass (leaves)	40.5	5.0	16.7
Taraxacum officinale (leaves)	31.7	3.9	41.7
Vicia sp. (leaves)	20.5	2.5	4.2
Robinia neomexicana (seeds)	15.1	1.9	16.7
Trifolium sp. (leaves)	9.1	1.1	4.2
Quercus sp. (acorns)	6.3	0.8	16.7
Bromus sp. (leaves)	6.0	0.7	29.2
Grasshopper	2.0	0.2	8.3
Daucus pusillus (leaves)	1.3	0.1	4.2
Dactylis glomerata (leaves)	1.0	0.1	4.2
Rudbeckia laciniata (leaves)	1.0	0.1	4.2
Sowbug	0.5	Tr	4.2
Insect Caterpillar	0.5	Tr	4.2
Lepidoptera Pupae	0.5	Tr	4.2
Unknown Seeds	0.3	Tr	4.2
Beetle	0.3	Tr	4.2
Ant	0.2	Tr	4.2
Tick	0.2	Tr	4.2
Box Elder Bug	0.2	Tr	4.2
Salix sp. (leaves)	0.2	Tr	4.2
Pseudotsuga menziesii (seed)	0.1	Tr	4.2
Unknown Forb (leaves)	0.1	Tr	4.2
Millipede	0.1	Tr	4.2
Nasturtium sp.	Tr	Tr	4.2
Lathyrus sp. (leaves)	Tr	Tr	4.2
Centipede	Tr	Tr	4.2
Diptera	Tr	Tr	4.2
Unknown Pupae	Tr	Tr	4.2

Total volume - 809.9 cc

Total vegetable - 703.4 cc.

Total animal - 106.5 cc.

Percent animal - 13.1.

Table 16. Gizzard contents of 26 adult male turkeys collected in the Sacramento Mountains in April 1981, 1982, 1983.

Food Item	Vol. (cc)	% Vol.	% Freq.
Unknown Vegetation	126.0	36.9	76.9
Juniperus sp. (seeds)	75.0	21.9	30.8
Poa sp. (leaves)	68.9	20.2	46.2
Unknown Seed	40.3	11.8	57.1
Bromus sp. (leaves)	19.9	5.8	11.5
Quercus sp. (acorns)	4.3	1.3	15.3
Taraxacum officinale (flowers)	2.4	0.7	15.4
Robinia neomexicana (seeds)	1.2	0.4	11.5
Vicia sp. (leaves)	1.2	0.4	3.8
Unknown Leafbud	1.0	0.3	3.8
Symphoricarpus oreophilus (seeds)	0.8	0.2	15.4
Prunus sp. (seeds)	0.8	0.2	7.6
Muhlenbergia sp. (leaves)	Tr	Tr	3.8
Isopod	Tr	Tr	3.8

Total volume - 341.8 cc.

Total animal - trace.

Grit - 427.0 cc.

in all cases except for the rested pastures during the month of August. In comparing grazed to rested pastures, biomass was greater in grazed pastures in all instances except for the riparian habitat during the month of August (Figure 27).

Representative insects in the samples were mostly of the orders Homoptera (leafhoppers and plant hoppers), Coleoptera (bettles), Hymenopters (ants and wasps), and Diptera (flies and mosquitoes). Leafhoppers and plant hoppers comprised the major portion of insects in all the samples. Arachnids (i.e. spiders) were also present in the samples.

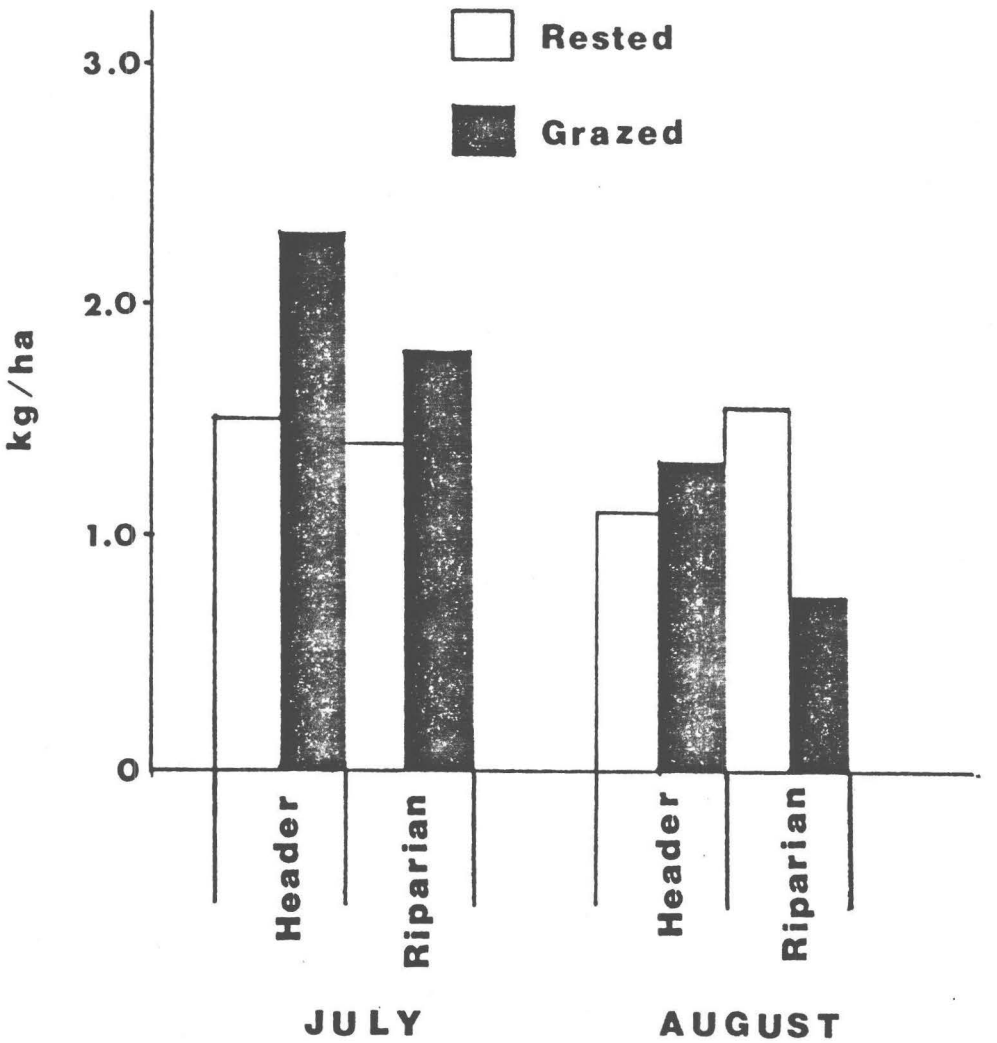


Figure 27. Insect biomass in rested versus grazed pastures within the rest-rotation grazing system.

DISCUSSION

Nesting Habitat

Nesting habitat was not a limiting factor in the Sacramento Mountains. Apparently, a wide variety of habitats fulfilled the necessary requirements. Both cool, mesic slope exposures and drier, xeric exposures with some (50%+) degree of overhead cover provided adequate nesting habitat. No real conclusions could be drawn connecting nest success with any parameters such as grazing and logging.

Grazing by livestock had no visible effect on nesting habitat because most nests were not located in areas utilized by cattle. Steep topography, dense understory vegetation or poor forage quality limited livestock use of areas where nests were located. In two instances where nests were in areas utilized by livestock, there was no loss in cover around the nest due to grazing.

Past selective cuts did not preclude a site from being selected for nesting by turkey hens and often provided nesting cover in the form of downed logs and slash. However, no nests were found in clearcuts of any size.

Nesting Success

The average nesting success (percent of nests in which one or more eggs hatch) of 31% in this study (Table 3) is only slightly less than the overall wild turkey average nesting success of 35% (Schorger 1966).

The most important factor limiting nest success was the abnormally low egg fertility (66%). Normally, an 87 to 98% fertility rate is expected for wild turkeys (Schorger 1966, Mosby 1967, Glidden and Austin 1975,

Petersen and Richardson 1975, Everett et al. 1980). The reasons for this anomaly were not evident, but possible explanations include:

1. There was a low density of gobblers available for breeding and many ovulating hens were not adequately inseminated.
2. The breeding of radio-tagged hens was somehow affected by their capture or tagging.
3. The spring gobbler hunt disrupted the breeding cycle.
4. Inclement weather disrupted the breeding cycle.
5. Poor nutrition lowered the fertility of males and/or females.

The first two do not appear to be likely explanations. Research with domestic turkeys (Hale 1955, Lorenz 1969) indicates that one breeding condition male may adequately inseminate 10 to 15 hens. A recent study by Nenno and Healy (1979) suggested that radio packages did not affect the behavior of wild turkey hens, and therefore should not interfere with breeding behavior.

Research in Alabama (Gardner et al. 1972, Everett et al. 1979) showed that managed spring hunting of gobblers did not affect that year's reproductive effort. However, the chronology of the spring gobbler season in New Mexico may be such that the breeding sequence is disrupted. The nesting season for turkey hens on the study area, determined from radioed hens, appears to begin the second week in May, peak around the first of June and continue through early July. The spring gobbler hunt occurs the second and third weeks in April, fully one month before hens are incubating. By shifting the spring season to a later date, when most hens are laying, if not incubating, the spring hunt would be less likely to disrupt courtship behavior.

The last two possible explanations, weather and nutrition, have been shown to significantly affect wild turkey reproduction and may influence fertility. Late winter storms in Missouri (Lewis 1961) disrupted mating with fewer and smaller broods reported. During the second spring of this study, a late snowstorm (May 3) could have been responsible for the poor hatch. Pennsylvania research by Gerstell and Long (1939) revealed that exposure to temperatures of -4°C or less will freeze turkey eggs. Temperatures below -4°C occurred on the study area as late as May 11 in 1979, and could have frozen many preincubation clutches. Therefore, inclement weather may have lowered egg fertility on the study area before and after laying began.

Research with domestic fowl indicates the strong relationship between adequate nutrition and successful reproduction in both males and females. Deficiencies in protein, calcium, other minerals and vitamins A, C, E and K can hinder fertility in both sexes (Beer 1969). Therefore, it appears that weather and/or nutrition may have been responsible for a loss of over 50% in reproduction potential in this population. The possible role of livestock grazing in lowering the nutritive quality of turkey diets should be considered in future studies, but for now, no conclusions can be drawn.

Abandoned nests were directly related to the fertility of eggs. During the first two years of the study 83% (5 of 6) of all abandoned nests involved wholly infertile clutches. Low nesting success in 1981 was probably due to the abandonment rate of 44% for this year.

Predation of turkey nests (31%) was low to normal when compared to other studies (Mosby and Handley 1943, McDowell 1956, Williams et al. 1968, Hillestad 1973, Wright 1975, Speake 1980), which reported predation

losses from 35 to 85%. If egg fertility had been normal and predation losses the same, nesting success would have been increased.

Brood-Rearing Habitat

Hens with poults utilized different habitats than had been used for nesting. Dense, seral brush used by many hens for nesting was abandoned in favor of more open conditions for brood rearing. Areas of lower canopy cover and higher herbaceous production provided the majority of brood-rearing habitat. The higher use of small openings rather than broad open meadows indicated the desirability of some overhead cover in combination with the increased herbaceous production that small openings provided. This preference for small ridgetop openings rather than large valley meadows negated the effects of grazing when comparing rested versus grazed allotments, primarily because valley bottoms were the main areas of livestock concentration. Since the majority of individual hens with poults selected grazed (60 sightings) pastures instead of rested pastures (20 sightings), it would seem that grazed areas are preferred over rested areas within the rest-rotation grazing system. This, however, could be a misconception due to the fact that, during any one year, more area was being grazed (6 pastures) than was being rested (3 pastures). Also, some grazed pastures were contiguous, allowing for large grazed areas that completely included the brood ranges of hens. In one instance this resulted in a 72.3 sq. km area that was grazed. In this case, a hen with poults within a grazed area would have to travel a great distance (from 6.4 to 13.7 km) to reach a rested pasture. Based on minimum home ranges (radius 2.65 km) some hens with broods would never reach rested pastures. Topographical features of the landscape may have also prohibited large scale

movements of hens with broods. Also, some hens with broods within rested pastures experienced complete brood mortality, due to some unknown factor or combination of factors. This mortality resulted in a low sample of brood site observations (especially in 1981 and 1982) in rested pastures.

Taking these factors into account one must conclude that brood habitat preference is not affected by livestock grazing at the current stocking rates on the area allotments. If one considers preference to be a reliable indicator of brood habitat quality, then existing moderate seasonal grazing (1 cow/32 ha on the study area) is not detrimental to turkey brood-rearing habitat.

By using the heights of Poa sp. on brood sites in the rested pastures as a standard, height/weight ratios show that there was little grazing on the grazed areas within the rest rotation grazing system ($\bar{x}$ Poa sp. height for rested pastures = 7.7 inches, $\bar{x}$ Poa sp. height for grazed pastures = 8.4 inches). This supports the observation that brood site areas were not utilized by cattle to an extent which would cause hens to choose one area over another for brood rearing.

In comparing the seasonal continuous system to the rested pastures within the rest-rotation grazing system, it was found that there was, on an average, a 25% reduction of grass height removed per brood site. This corresponds to a 1.65% reduction in weight which is in the "very light grazing" category. This lower grass height ($\bar{x}$ Poa sp. height for seasonal continuous grazing system = 5.8 inches) also could be attributed to site differences and not solely to grazing influences.

One factor that may have confounded these results was the occasional presence of cattle in rested pastures during the study. Cattle were present in rested pastures due to downed or broken fences.

The relative abundance of grazing "decreasers, increasers, and invaders" indicates past grazing pressure and departure from ungrazed "pristine" conditions. Since all categories were well-represented in brood site importance indices, brood habitat selection is not relegated purely to species that decrease or increase in response to grazing, but to a wide variety of plant species. Moderate grazing may even promote turkey brood-rearing habitat by keeping vegetation cropped, which facilitates poult movement, and by stimulating new growth conducive to insect abundance (Hillestad and Speake 1970, Williams et al. 1973, Speake et al. 1975). Hewitt et al. (1974), in a review of rangeland entomology, found that in most instances grazing caused substantial increases in many insect species, particularly grasshoppers, a major component of young poult diets (Burget 1957, Hoffman 1962, Jonas 1966, Schorger 1966, Korschgen 1967).

Selective cutting appears to enhance brood-rearing habitat by providing small, patchy openings rich in grass and forb cover. These small openings were utilized even more than the true meadow types, wet and dry, and provided concealment from potential predators.

Brood-Rearing Success

The small sample size of radioed broods precludes any valid analysis of overall poult mortality, but the fact that all poults were eventually lost in 1980 suggests that predation, or some other unknown factor (i.e., disease, weather, etc.), can severely limit production after hatching.

Roosting Habitat

Roosting habitat was widespread in the Sacramento Mountains. A large variety of tree species, sizes, ages and densities served as roosts.

Summer roosts appeared to be selected randomly, while winter roosts showed definite selection factors which warrant consideration.

Winter roosts generally indicated high use areas and concentrations of winter flocks. Exposure to early morning insolation apparently makes easterly slopes the desired aspect. Also, predominant winter winds are from the southwest and a northeast slope provides the greatest protection, especially during inclement weather.

The main forestry practice that could adversely affect roosting habitt would be clearcutting of large areas. Isolated stands within a clearcut block probably would not be utilized due to inaccessibility from other contiguous stands and the absence of travel corridors provided by overstory canopy cover (Gehrken 1975).

This study seems to indicate that selective cuts do not lower the potential of an area as an adequate roost site nor do overmature trees have to be left to serve as actual roost trees. A minimum residual BA of 18 m^2/ha (approximately 80 ft^2/acre) with some sawlog-size trees (30 cm+ dbh) should meet the minimum roost requirements of turkeys.

Many roost sites are on steep slopes which have been protected from major disturbances since they are inaccessible to logging as it is currently being practiced. Increased implementation of cable logging practices, in the future, could make these turkey roost sites vulnerable to cutting. Care should be taken to perpetuate perenially used roosts.

Food Habits

Turkeys consume a diversified diet. This wide use of various plant and animal foods allows turkeys to successfully cope with seasonal and

annual variation, in particular food availability, and survive periods of adversity caused by localized food shortage. Although turkeys seek variety (Williams 1982), certain foods such as grasses, leaves, sedge, acorns and insects were important in Merriam's turkey food studies in Colorado, Arizona and New Mexico (Korschgen 1967). Two important foods in our study not previously reported in other food studies are watercress and locust leaves and seeds. The high rate of usage of watercress (Table 14) during the winter by Merriams turkey emphasizes the importance of springs with open water and aquatic vegetation during winter periods of deep snow when other foods are scarce or unavailable. Eastern wild turkeys on the northern edge of their range in Michigan (Janson 1963), West Virginia (Glover 1947, Bailey and Rinell 1948, Healy 1977) and Pennsylvania (Latham 1959) show similar heavy feeding activity at springs during the winter.

Insect Biomass

Insects comprise a major portion of the diet of turkey poults, especially during the first few weeks of their life. Insects in the orders Homoptera, Coleoptera, Orthoptera, Lepidoptera, Hemiptera, Hymenoptera, and Diptera are frequent foods of turkey poults (Hurst and Stringer 1975). In Alabama, Blackburn et al. (1975) found that the percent of animal matter in the diet of turkey poults decreased from high of 54% in June to 3% in September.

Insects are most available during the summer months. Dalke et al. (1946) reported that insects were at maximum numbers during June. This coincides with the peak hatch time of the wild turkey reported by Mosby and Handley (1943). Insect biomass was greater in July than in

August during our study. This would allow for an increased availability of insects for poults during the early stages of life.

Higher insect biomass in grazed versus rested pastures indicates that the light to moderate grazing on the study area may lead to increased insect production. Holmes et al. (1979) observed that grazing by livestock promoted an increase in the number of grasshoppers.

The greater insect biomass in "header" canyons versus riparian zones may be due to many factors. Some of these factors may include temperature ("header" canyons being cooler during the hot parts of the day), differences in the structure of the vegetation, and differences in the types of vegetation found within the 2 zones. The "header" canyons tended to be more indicative of typical brood rearing sites, and the increased insect biomass in these areas could be a reason for the choice of these types of areas over the more open, riparian areas. This also may be a reason for this choice of habitat over more forested areas. Martin and McGinnes (1975), in a study in Virginia, found 25 times more insects in clearings than beneath the forest canopy.

MANAGEMENT RECOMMENDATIONS

Many of the land management practices currently being implemented on the Lincoln National Forest are compatible with good turkey management.

Timber

1. Plan timber sales to create an interspersion of cover types. Cut selectively or by group selection whenever possible to create sparse stands or small (less than 5 acres), irregularly shaped clearings preferred by brood-rearing hens.

2. When cruising timber for cutting, always identify winter turkey roosts for preservation. This should include not only roost trees but also all trees within the roost area. Heavy dropping accumulations will indicate which trees are being used repeatedly. Give particular attention to favored north to east slopes, especially when these slopes are within ¼ mile of a permanent water source.

3. When cutting north and east slopes where no active roosts are found, make allowances for potential roost sites by leaving clumps of trees with at least 8 conifers within a ¼-acre area. The roost area and the trees in it should exhibit the following minimum parameters:

   a. Tree dbh of 13 inches (preferably 18 inches).
   b. Tree height of 40+ feet (preferably 70 feet).
   c. Canopy cover of 55% (preferably 65%).
   d. Basal area of 100 $ft.^2$/acre (preferably 165 $ft.^2$/acre).
   e. Accessibility from a small clearing or opening directly upslope.

When planning to cut large areas, leaving at least 2 potential roost sites per 1 sq. mile should provide adequate roosting habitat, provided these sites are not isolated from the residual stand.

4. Encourage thinning of dense mixed-conifer stands to increase understory herbaceous production. Basal areas approaching 65 $ft.^2$/acre and canopy covers as low as 40% are optimum for brood-rearing habitat.

5. Avoid brush control that involves eradication of valuable mast producing species or vegetation types like Gambel oak, pinyon pine and juniper, especially where these types are adjacent to ponderosa pine or mixed-conifer types.

6. Do not pile or burn all slash. If possible, leave slash, especially on slopes in a random arrangement on selected areas. This provides quality nesting cover.

7. Avoid extensive applications of pesticides, especially during summer months when insects are an essential food item for turkey poults.

8. Avoid reforestation planting of small clearings and natural openings 10 acres or less, particularly those at the upper ends of canyons and at higher elevations. These areas are important for brood habitat and should be maintained as open area.

9. Curtail use of insecticides during the summer brood season to avoid adversely impacting insects, a key poult summer food.

10. Use a mixture of grasses and legumes when reseeding for erosion control on skid roads or on other disturbed areas. Particularly desirable are large or abundant seed producers. Such grasses as fescues, wheatgrasses, orchard grass, wild oats and timothy grass, and legumes such as vetch, pea vine, clover, and sweet clover can all provide valuable turkey forage.

Grazing

1. Nesting cover is generally unaffected by grazing since hens rarely nest in the meadow habitat. Meadows are mainly foraging areas.

2. Moderate grazing (30–50% utilization) in mixed-conifer types apparently does not adversely affect the quality of summer turkey range. Differences in the effect of rest-rotation and continuous grazing systems (at similar stocking rates) on turkey summer habitat are not apparent from existing data. Cover for broods is provided primarily by tree overstory or shrub vegetation, and less by the herbaceous understory vegetation which is affected by grazing.

3. The most important effects of grazing on turkey habitat are a change in grass species composition and reduced grass seed production. A continuous grazing system where livestock are removed on at least some pastures by late August or early September may allow increased seed production. The rest-rotation system with some totally rested pastures would also increase grass seed production.

4. Moderate grazing has been shown to actually increase many insect species, particularly grasshoppers, an important part of turkey poult diets.

5. Develop watering facilities that will be effective during the normally dry nesting season, May through June. When developing livestock watering facilities, consider accessibility for turkey and proximity to cover. When piping water over long distances, provide drip stations. If fences surround a spring or tank, provide at least 18 inches clearance between the bottom strand of smooth wire and the ground. Avoid conventional metal tanks with high sides, or provide entrance and exit ramps that will provide access to water in these tanks.

6. The importance and enhancement of spring seeps containing watercress needs recognition. Fencing of seeps to avoid trampling and siltation by livestock is suggested. Water for cattle can be maintained by pipes to troughs.

7. Grazing exclosures near water that contain small food plots (¼ to ½ acre) of cultivated oats, wheat, or barley should be considered where locally intense grazing is unavoidable. If located on south to west exposures, these plots will be accessible during the winter when snow accumulation makes other exposures unattractive for feeding turkeys.

8. Revegetation projects should be geared toward maximum diversity of plant species. Such diversity provides more of a

year round forage base (e.g., early growing forbs provide protein rich food before grasses have even sprouted).

Recreation

1. Discourage camping and other intensive recreational uses around water sources, particularly isolated springs that may be locally critical in supplying turkeys and other wildlife with a dependable water source. No camping within ¼ mile of water sources would probably greatly increase water availability in heavily used recreation areas.

2. Perennial winter roosts should be recognized as vital winter turkey habitat indicators. Limiting vehicle access and camping around these winter roosts would decrease human disturbance of wintering turkey flocks.

3. The discouragement of vehicle use of ridgetop roads by seasonal closure from June 1 - August 15 would curtail disturbance of turkey hens with broods. Road closures along and adjacent to meadow bottoms also would be beneficial to wild turkeys.

General

1. Many choice turkey habitats along meadow bottoms are in private ownership (Figure 28) and threatened by development. Priority should be given to acquisition of private tracts within key turkey habitats.

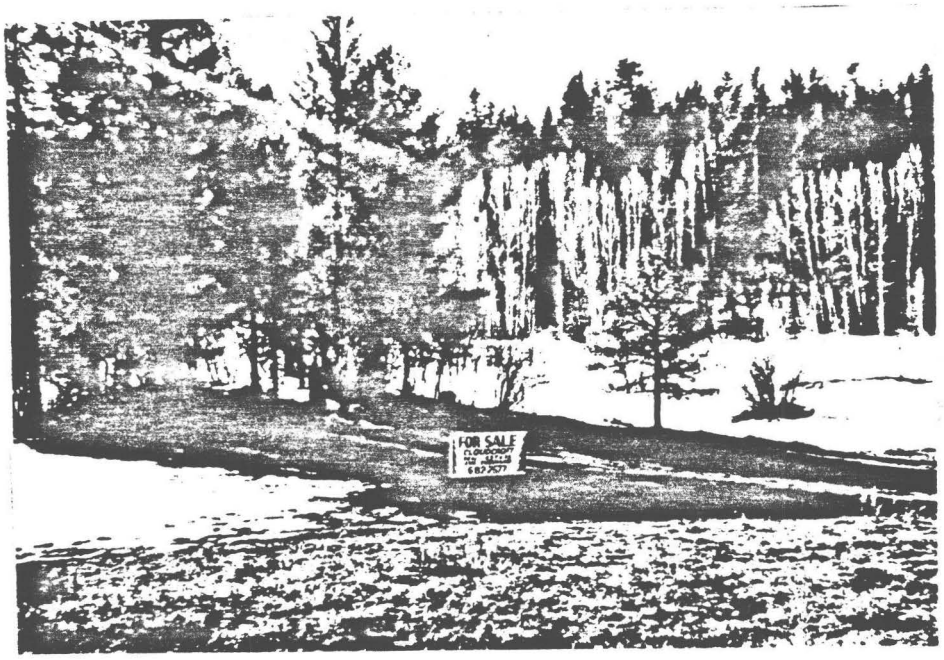


Figure 28. An example of private land for sale, near Aspendale, within Lincoln National Forest which poses a threat to wild turkey habitat.

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APPENDIX A

A Brief Description of Habitat Types and Seral Types on the Study Area

A Brief Description of Habitat Types and Seral Types on the Study Area [the first six types are taken directly from Moir and Ludwig (1979)].

1. Engelmann spruce/Rocky Mountain maple HT (Picea engelmannii/Acer glabrum HT)

   Picea engelmannii is the predominant overstory species with Pseudotsuga menziesii the most important codominant. Acer glabrum is present in the understory. Herb cover varies from 5 to 17% with Bromus ciliatus, Viola canadensis, Smilacina stellata and Ligusticum porteri the most common species (2700-2950 m).

2. Blue spruce/Kentucky bluegrass HT (Picea pungens/Poa pratensis HT)

   Pidea pungens occurs in all sizes and dominates regeneration. Salix scouleriana, Prunus virginiana and Acer glabrum form the shrub stratum. Extremely rich and diverse herbaceous vegetation includes Poa pratensis (3 to 70% cover), Fragaria sp., Erigeron superbus, Geranium richardsonii, Equisetum sp., and Viola canadensis. Occurs along streamsides, tributary draws and alluvial terraces (2440-2750 m).

3. Blue spruce-Douglas fir HT (Picea pungens - Pseudotsuga menziesii HT)

   Picea pungens and Pseudotsuga menziesii codominate as climax species on valley slopesides (rather than alluvial terraces or valley bottoms). A tall shrub layer may be represented by Quercus gambelii and Acer glabrum, but is typically sparse. Low shrubs include Rosa sp., Lonicera arizonica and Jamesia americana. Characteristic herbs are Valeriana acutiloba, Bromus ciliatus, Fragaria sp., Poa fendleriana, Aquilegia sp., and Cystopteris fragilis. Occurs on northerly aspects (2380-2470 m).

4. White fir-Douglas fir/Rocky Mountain maple HT (Abies concolor - Pseudotsuga menziesii/Acer glabrum HT)

   Either or both Abies concolor and Pseudotsuga menziesii dominate the forest regeneration. Pinus ponderosa is a minor seral constituent. A tall shrub layer is characteristic and consists of Acer glabrum, Acer grandidentatum and to a lesser extent Quercus gambelii and Salix scouleriana. The low shrub layer includes Holodiscus dumosus, Symphoricarpus oreophilus, Jamesia americana and Rosa woodsii. Major herbs are Bromus ciliatus, Artemisia franseroides, Clematis Pseudoalpina, Haplopappus parryi and Lathyrus arizonicus. Occurs on easterly to northwesterly aspects (2400-2900 m).

5. White fir-Douglas fir/Gambel oak HT (Abies concolor - Pseudotsuga menziesii/Quercus gambelii HT)

Either or both Abies concolor and Pseudotsuga menziesii dominate forest regeneration with Pinus strobiformis and P. ponderosa common seral trees. Quercus gambelii is the dominant understory constituent with Robinia neomexicana often subdominant. Bromus ciliatus, Poa fendleriana and Carex rossii are major graminoids and Geranium caespitosum, Erigeron sp. and Artemisia ludoviciana common forbs. Occurs on moderate to steep canyon sideslopes and generally west, south, and easterly exposures (2340-2800 m).

6. White fir-Douglas fir HT (Abies concolor - Pseudotsuga menziesii HT)

Either or both Abies concolor and Pseudotsuga menziesii occur in all size classes with crown dominance by Abies, Pseudotsuga, Pinus strobiformis and P. ponderosa in closed canopy. The understory has very sparse shrub and herbaceous cover, mostly less than 1%. Occupies moderate to steep, north to east facing slopes (2450-2800 m).

Dry Meadow Type

1. Elderberry/Kentucky bluegrass HT (Sambucus caerula/Poa pratensis HT)

Sambucus caerula is the only common shrub but may be sparsely represented. This is a true meadow type occurring along tributary draws with Poa pratensis comprising the major vegetative cover. Artemisia ludoviciana, Helenium hoopesii, Rudbeckia lacinata, Achillea lanulosa, Vicia americana, Iris missouriensis and Taraxacum officinale are common forbs. This HT occurs on all aspects, wherever a combination of deep alluvial soils and cold air drainage prevent the invasion of mixed conifer tree species (2100-2960 m).

Seral Types

1. Aspen ST (Populus tremuloides ST)

Populus tremuloides dominates the overstory (50%+). Shrub understory is usually lacking. Herbaceous ground cover may be high along meadow borders or almost absent when located within dense mixed conifer types. Slopes are generally north to easterly in aspect (2400-2900 m).

2. Ponderosa pine/wavyleaf oak ST (Pinus ponderosa/Quercus undulata ST)

A sparse overstory of Pinus ponderosa with a thick understory of Quercus undulata is typical. Other shrub species may include Ceanothus montanus, Rosa fendleriana, Q. gambelii and Prunus virginiana. This dense shrub layer allows little herbaceous vegetation to occur. A common fire sere, this ST occupies steep, southerly slopes and dry ridge exposures with shallow soils (2100-2700 m).

3. Gambel oak ST (Quercus gambelii ST)

Quercus gambelii is the dominant overstory species, but minor overstory constituents may include Pinus ponderosa, Abies concolor and Pseudotsuga menziesii. Shrubs may consist of Rosa fendleriana, Holodiscus dumosa, Symphoricarpus oreophilus and Ribes sp., Bromus sp., Muhlenbergia montanus, Smilacina stellata, Aquilegia sp., and Galium boreale are common herbaceous species. This type occupies more mesic sites than the Pipo/Quun ST, but occurs on less mesic sites than the Potr ST (2250-2800 m).

4. Pinyon-juniper/wavyleaf oak ST (Pinus edulis - Juniperus deppeana/Quercus undulata ST)

Pinus edulis and Juniperus deppeana form a widely spaced overstory with Quercus undulata forming a thick shrub layer. This is not the typical pinyon-juniper climax type, but a fire sere occurring at lower elevations in ponderosa pine habitat types. It is very similar to the Pipo/Quun ST, but with P. edulis and J. deppeana replacing P. ponderosa in the overstory.

APPENDIX B

List of Scientific Names

LIST OF SCIENTIFIC NAMES

Common Name	Scientific Name
Grasses*	
Bluegrass	*Poa* sp.
Bottlebrush squirreltail	*Sitanion hystrix*
Brome grass	*Bromus* sp.
Dropseed	*Sporobolus* sp.
Fescue	*Festuca* sp.
Grama, blue	*Bouteloua gracilis*
Junegrass	*Koelaria cristata*
Lovegrass	*Eragrostis* sp.
Muhly	*Muhlenbergia* sp.
Needlegrass	*Stipa* sp.
Oats	*Avena fatua*
Orchard grass	*Dactylis glomerata*
Redtop	*Agrostis* sp.
Ryegrass, perennial	*Lolium perenne*
Sleepygrass	*Stipa robusta*
Three-awn	*Aristida* sp.
Timothy	*Phleum alpinum*
Wheatgrass	*Agropyron* sp.
Wildrye, Canada	*Elymus canadensis*
Forbs	
Aster	*Aster* sp.
Baneberry	*Actea rubra*
Bedstraw	*Galium* sp.
Brickellia	*Brickellia grandiflora*
Buckwheat	*Erigonum* sp.
Carrot, wild	*Daucus pusillus*
Chickweed	*Cerastium arvense*
Cinquefoil	*Potentilla* sp.
Clover	*Trifolium* sp.
Columbine	*Aquilegia* sp.
Cosmos	*Cosmos parviflora*
Cranesbill	*Geranium atropurpureum*
Cutleaf coneflower	*Rudbeckia laciniata*
Dandelion	*Taraxacum officinale*
Dogbane	*Apocynum* sp.
Elkweed	*Swertia* sp.
Erysimum	*Erysimum* sp.
Eveningprimrose	*Oenothera* sp.

*Nickerson et al. (1976) is the source used for scientific plant names.

Common Name	Scientific Name
Forbs (Continued)	
False solomon seal	Smilacina palustris
Figwort	Scrophularia sp.
Fleabane	Erigeron sp.
Gentian	Gentiana sp.
Goldenrod, Missouri	Solidago missouriensis
Groundsel	Senecio sangusorboides
Gumweed, curlycup	Grindelia squarrosa
Heronbill	Erodium sp.
Horsetail	Equisetum sp.
Indian paintbrush	Castilleja sp.
Iris	Iris missouriensis
Lambsquarter	Chenopodium album
Louisiana wormwood	Artemisia ludoviciana
Meadowrue	Thalictrum fendleri
Milkweed	Asclepias sp.
Mint	Mentha sp.
Mountain parsley	Pseudocymopterus montanus
Mullein	Verbascum sp.
Myrtle, boxleaf	Pachystima myrsinites
Nettle	Urtica sp.
Nightshade	Solanum sp.
Onion, wild	Allium sp.
Pea vine	Lathyrus sp.
Penstemon	Penstemon sp.
Plantain	Plantago sp.
Polemonium	Polemonium sp.
Salsify	Tragopogon dubuis
Sandwort	Arenaria sajanensis
Sedge	Carex sp.
Selfheal	Prunella vulgaris
Skyrocket	Ipomopsis aggregata
Sneezeweed, orange	Helenium hoopesii
Squawroot	Conopholis mexicana
Starwort	Stellaria sp.
Strawberry, bracted	Fragaria bracteata
Sweet clover	Medicago sp.
Sweetroot	Osmorhiza sp.
Thistle	Cirsium sp.
Vervain	Verbena sp.
Vetch, American	Vicia americana
Violet	Viola sp.
Virginsbower	Clematis neomexicana
Watercress	Nasturtium sp.
Wood sorrel	Oxalis sp.
Yarrow, western	Achillea lanulosa

Common Name	Scientific Name
Shrubs	
Brickellia, tasselflower	*Brickellia grandiflora*
Currant	*Ribes* sp.
Elderberry	*Sambucus caerula*
Honeysuckle	*Lonicera* sp.
Jamesia	*Jamesia americana*
Mountain mahogany	*Cercocarpus* sp.
New Mexico locust	*Robinia neomexicana*
Nine-bark	*Opulaster* sp.
Ocean spray	*Holodiscus dumosus*
Raspberry	*Rubus* sp.
Rose, Fendler	*Rosa fendleriana*
Snowberry	*Symphoricarpus oreophilus*
Willow	*Salix* sp.
Trees	
Alligator juniper	*Juniperus deppeana*
Ash	*Fraxinus* sp.
Aspen	*Populus tremuloides*
Bigtooth maple	*Acer grandidentatum*
Blue spruce	*Picea pungens*
Cherry	*Prunus* sp.
Chokecherry	*Prunus virginiana*
Douglas fir	*Pseudotsuga menziesii*
Engelmann spruce	*Picea engelmannii*
Gambel oak	*Quercus gambelii*
Limber pine	*Pinus flexilis*
Pinyon pine	*Pinus edulis*
Ponderosa pine	*Pinus ponderosa*
Rocky Mountain maple	*Acer glabrum*
Scrub oak	*Quercus* sp.
Southwestern white pine	*Pinus strobiformis*
Wavyleaf oak	*Quercus undulata*
White fir	*Abies concolor*
Mammals	
Coyote	*Canis latrans*
Mountain lion	*Felis concolor*
Raccoon	*Procyon lotor*
Skunk	*Mephitis mephitis*

APPENDIX C

Density Board Measurements

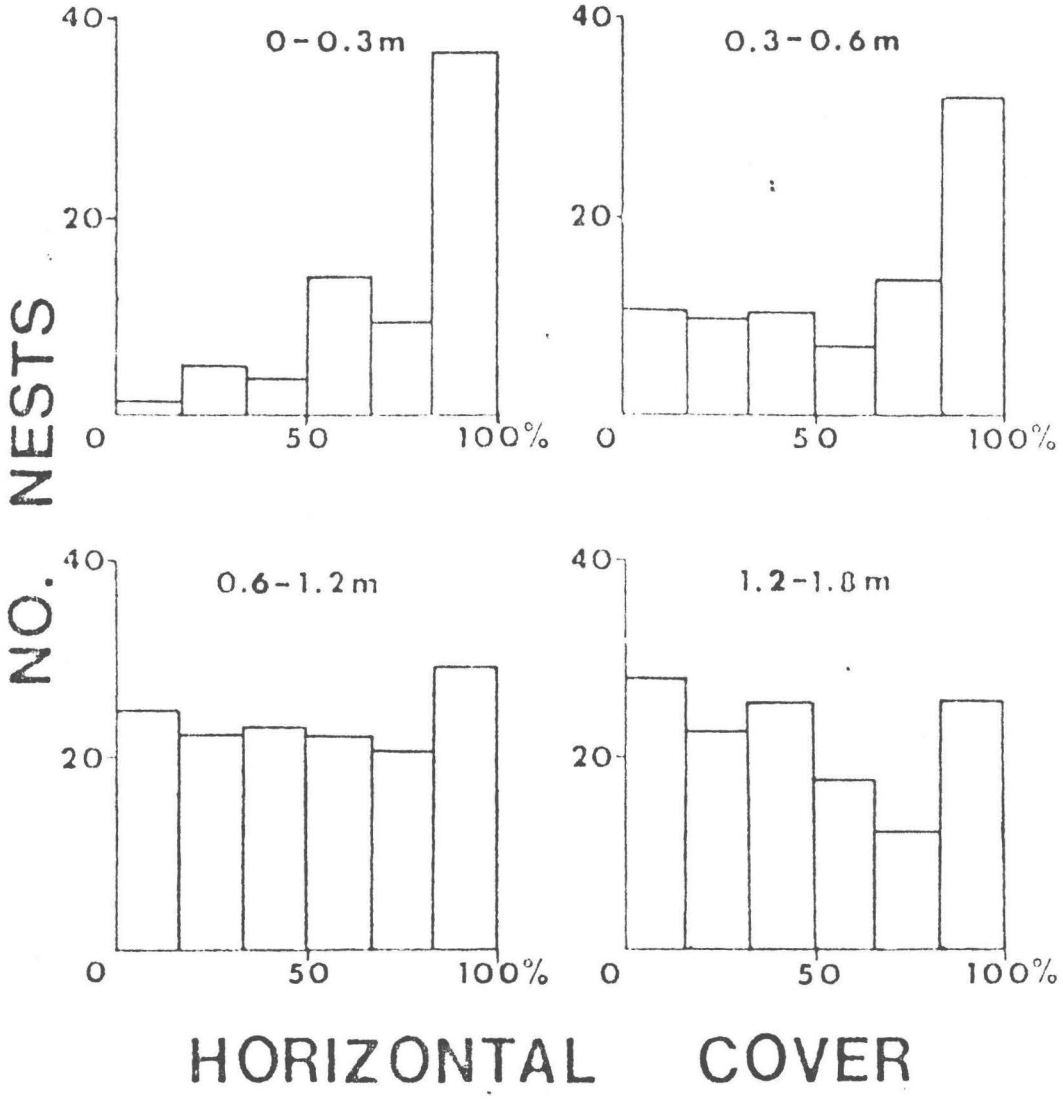

Figure 29. Distribution of horizontal cover around nests at different above ground heights, 20 m from nest (cover categories: 0-9%, 10-24%, 25-49%, 50-74%, 75-90%, and 91-100%).

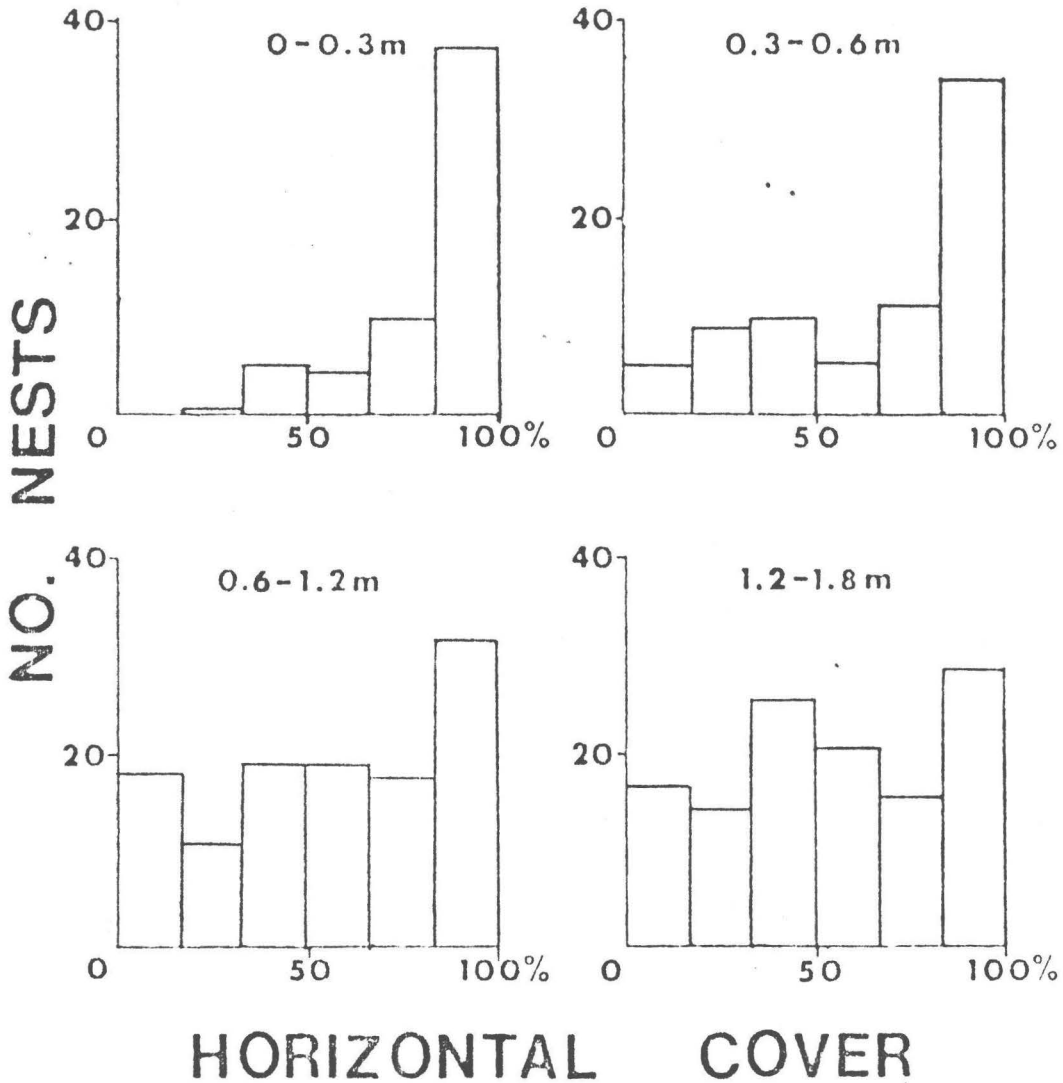

Figure 30. Distribution of horizontal cover around nests at different above ground heights, 30 m from nest (cover categories: 0-9%, 10-24%, 25-49%, 50-74%, 75-90%, and 91-100%).

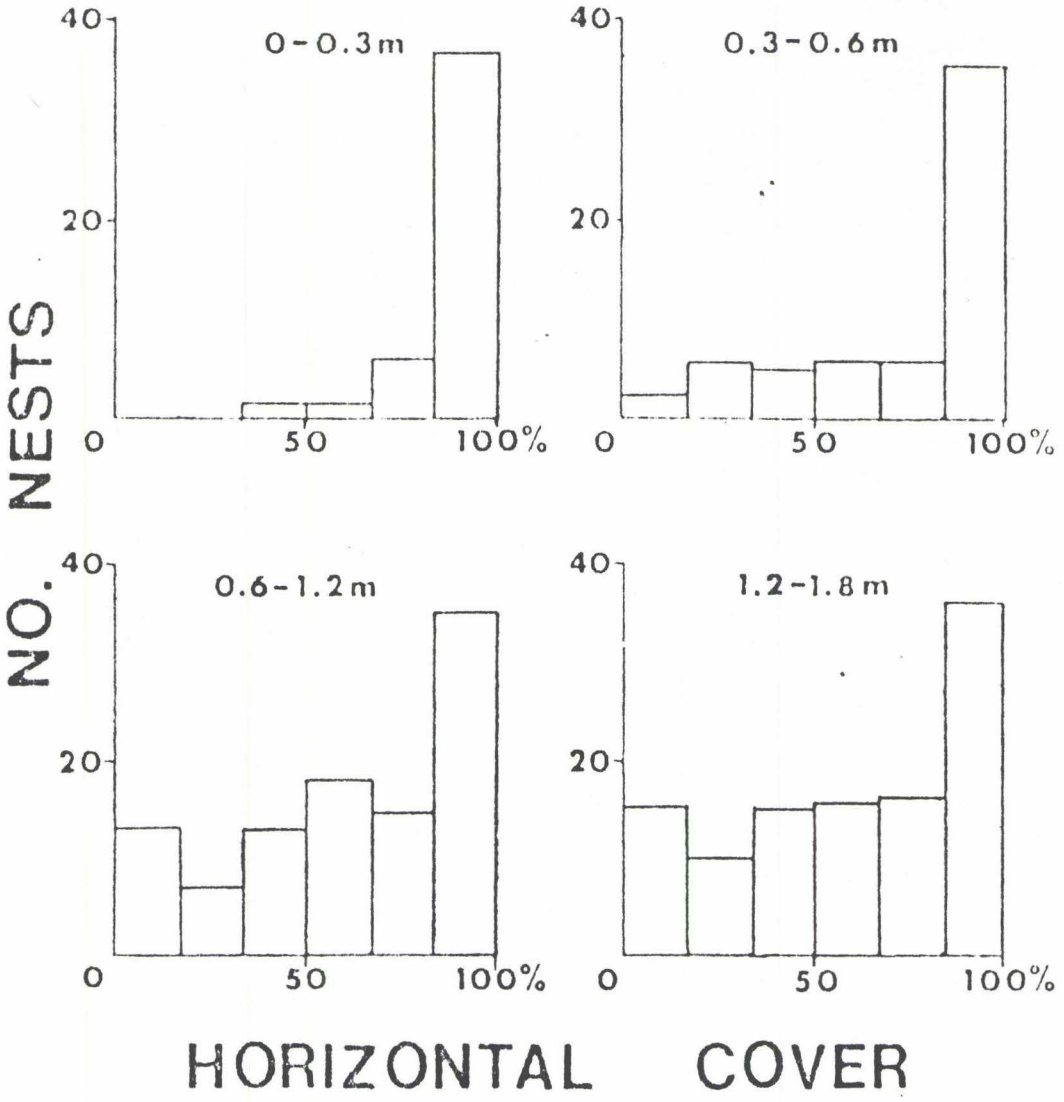

Figure 31. Distribution of horizontal cover around nests at different above ground heights, 40 m from nest (cover categories: 0-9%, 10-24%, 25-49%, 50-74%, 75-90%, and 91-100%).